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POWER

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Killing Time

WHAT are you doing?

Man is so constituted that every waking, conscious minute, with head or hand, with mind or muscle, he must be doing something.

And when he is doing whatever he is, he is not doing something else.

That may be for the better or the worse.

About the nearest case that I ever saw to complete inanition in a healthy man was that of a fellow who tends a bridge that crosses a stream in a lonesome country.

A boat goes through only occasionally and few are large enough to require the draw to be opened.

The tender has a wealth of time on his hands. He could put himself into touch with the best thought of the world, make the treasures of literature his own, learn a language or two, master a science.

One of the leaders in the development of geology studied his way into it while cobbling shoes.

But if this fellow had the interest and animation to do any of these things, he would not be tending a drawbridge on a country highway.

I wonder what the mental attitude and processes of such a man can be; what his mind keeps busy about in its limited scope.

I watched a prosperous looking man in a railway car working for hours on a crossword puzzle. And I speculated on the aggregate worth of all the time that is spent by all the people of his and lesser abilities on such pursuits.

The watch engineer in a power plant has an abundance of time for thought and study. Some kill it with inconsequential things.

Some use it in reading and study and thinking, in manifesting a live, intelligent, questioning interest in what is going on about them that makes them masters of engineering.

Some of the best power engineers in the business came into their own in this way.

F. R. Low

POWER *Stands for . . .*

1. **Making Power When It Should Be Made**
2. **Buying Power When It Should Be Bought**
3. **Cheaper Power Through Modern Equipment**
4. **Easier Financing of Equipment Purchases**
5. **Better Use of Byproduct Heat and Power**
6. **Operating Methods That Save Money**
7. **Less Waste in Transmission and Application**

Sun Spots and Steam Flow

"SUN spots a factor in predicting steam flow for power generation"—this rather surprising statement headed an article in the April 16 issue. Obviously a typographical error and a rather amusing example of what may happen when an "r" is dropped.

And yet, not to make an alibi but to point out a simple fact, it *is* true that sun spots are a factor in predicting "steam flow" as well as "stream flow."

In his noteworthy article the author demonstrated a definite relation between the eleven-year sun spot cycle and the cycle of rainfall and runoff.

This being granted, it is obvious that the solar sun spot cycle must also have its effect on steam generation. Much of the country's hydro-electric power is tied in with steam. Deficiencies in water-power supply are made up by steam-generated power. Thus it is clear that the sun spots do have an important, although indirect, influence on steam flow. Once more it is seen that events, remote in space and apparently disconnected, may be closely related.

Greater Capacity per Unit Space

OPERATING economy and decreased maintenance are advantages always considered when justifying the replacement of old equipment. Frequently, however, neglect to consider the value of increased capacity obtainable from new equipment has caused a legitimate improvement to be abandoned.

A modern boiler, for example, can be relied upon to generate two to three times the amount of steam available from a unit of the same size installed ten years ago. Likewise the trend toward higher pressures permits a considerably greater output from prime movers per unit of floor space.

A striking illustration of the difference in space required by new and old equipment is seen in the Ross pumping station described in this number. Two boilers, operating at 330 lb. pressure, and two turbine-driven pumps recently installed in this station will handle the entire station load, although they occupy only one-third of the floor space previously needed. The remaining space in the present building is thus made available for future pumping requirements.

While the greater capacity obtainable from present-day equipment should be kept in mind, credit should not be allowed for it unless this extra capacity is needed. This, however, is generally the case, as most industrial plants require increased power services as their manufacturing operations grow.

Thermometer Terminology

THE Power Test Codes Committee of the A.S.M.E. is seeking suggestions relative to terminology covering indicating and recording thermometers that depend for their operation upon the expansion of liquids, the vapor tension of volatile liquids and the expansion of gas. Existing terms are generally inadequate in identifying many of the modern instruments and some are actually misleading. Several of the manufacturers employ the simple designations of Class I, Class II and Class III. While this is convenient for their individual purposes, it means little to the user.

It is possible that some readers may have constructive suggestions to offer that will be of assistance to the committee in arriving at a convenient and definite terminology.

Clean Coal Versus Stack Ash

ONE step which would in a large measure reduce the quantity of fine ash discharged from stacks of plants burning pulverized coal would be cleaning the coal before shipment from the mines. Many American coals are sufficiently low in ash that coal cleaning would not pay. Coals carrying much pyrite could be cleaned with considerable resultant gains for this material rapidly destroys the parts of pulverizing mills and increases the power requirements per ton for grinding. Furthermore, the ash from this material tends to flux with furnace refractories and to form easily fusible liquid slags. Cleaning should also eliminate much of the usual slate and refuse in coal.

Coal is usually cleaned by one of the many types of wet washers. Several of these have been in use for some time in this country. The objection to such washers is that the coal leaves them in a wet state, that freight has to be paid on this water content, that the wet coal must be dried before use as pulverized fuel and that cars of this coal freeze solid in winter and are thus difficult to unload.

Many attempts to dry-clean coal have been made and some processes appear to have solved the problem at least for certain coals. These in general depend upon oscillating decks on which the gravity separation of coal and dirt is aided by a certain degree of air separation. When these processes are fully developed many of the

objections to cleaned coals will have been overcome, since the product contains no added moisture.

Clean coal, having been thus processed, will naturally cost somewhat more per ton than raw coal. This increased cost will be offset by the freight charges now paid on ash contents, and by the saving from having to remove less ash from the furnace bottoms and to wash less dust from the flue gases. The cleaning of coal deserves further attention both from the coal producer and the users. The inherent advantages of dry cleaning should give an impetus to the more complete development of such processes.

Power Plants and Profits

ONE of the reasons given for the lack of interest by managements in their power plants is that these plants do not pay dividends. The power plant is looked upon as a source of expense and as a necessary evil. A little analysis of this idea will show that it is out of line with the facts. It would be just as reasonable for a manufacturer to say that the finished product is all that interests him because it is the only thing that produces income, as not to be interested in the power and heating supply because they are items of expense.

Every operation from the purchase of raw materials to the delivery of the finished product to the consumer is an item of expense. Raw materials, power, labor, manufacturing machines, shipping, sales, distribution—all are items that must be paid for. It is the difference between the selling price and the cost of producing and delivering the goods to the customer that spells profit. If the production cost can be decreased by reducing the cost of raw materials, power and heat, labor, or manufacturing processes or by reducing any of the other costs, under a given set of market conditions, profits will increase. Therefore, why single out the power plant as the one item of expense to be treated as a necessary evil? Fifty thousand dollars saved in the operation of the power plant will go as far toward paying dividends as a like amount saved by improved manufacturing processes or by using better sales methods. Anything done to reduce the total cost of the product delivered to the consumer will increase the profits.

Progressive managements are looking to their power plants as a place where profits may be made. The president of a large department store is intensely interested in the cost of operating his power plant. He considers it one of his most profitable departments. Although it does not directly produce income, he realizes that if it is neglected the increased cost can easily eat up the profits made in other departments. For this and other reasons the power plant is considered one of the best paying departments. Periodic statements on the cost of its operation are just as carefully considered as are those coming from any other department.

Purchased power does not relieve management of responsibility for the power plant. A recent instance comes to mind of a manufacturing plant where power is purchased. Modernizing the power equipment and putting it in proper operating condition cut the power bill about twelve thousand dollars a year. In addition a material reduction in operating and manufacturing costs and other benefits resulted.

Whether the power plant pays dividends or not, if it is properly managed there will be a greater share of the total income available for net profits. The management that gets no closer to his plant engineer than the length of the telephone line between their offices is missing a big bet.

High Pressures and the "Condensing-Water" Bogey

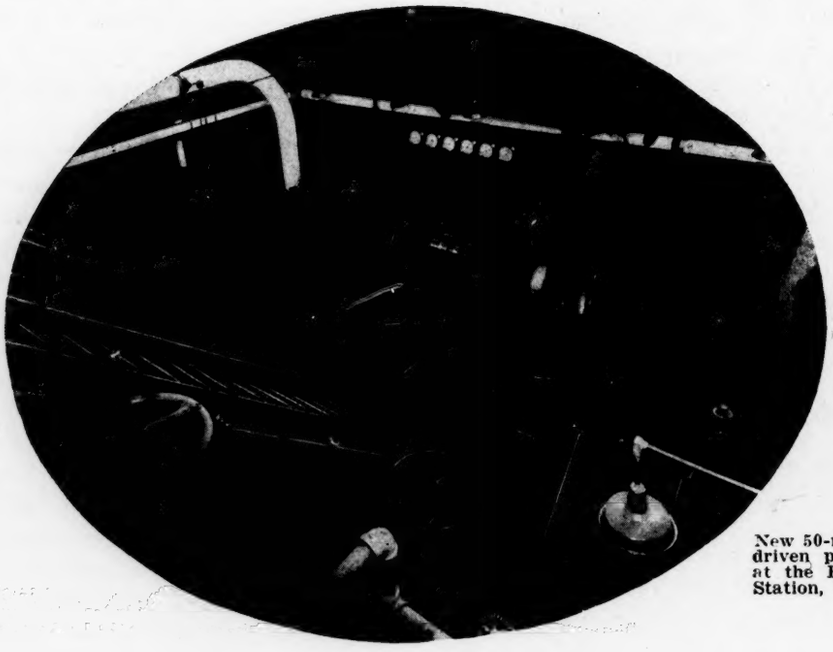
MANY of the traditions of power generation will have to be re-examined in the light of new conditions established by the demonstrated practicability of twelve-hundred-pound steam-electric stations. One such is the supposed controlling effect of condensing-water supply on the location of power stations.

In the past, advocates of mine-mouth power plants (mostly non-engineers) were silenced with statements of the tons of condensing water required per ton of coal. High vacuum was taken for granted and an enormous amount of condensing water became thereby an absolute necessity. High initial pressure reduces the weight of steam condensed and makes high vacuum so much less important that it may in certain cases pay to sacrifice two or three inches of vacuum. Considerable amounts of power may thus be generated on streams of moderate size near coal mines. Where no natural supply of circulating water is available, the possibilities of cooling ponds and towers may be worth reconsideration in view of the greatly reduced volume of water that it becomes necessary to handle.

While decreased vacuum cuts down the cost of condensing equipment, it raises the fuel consumption and, with it, the cost of boilers and all boiler-room equipment. It seems clear, however, that certain border-line locations that did not quite warrant development on the basis of a 400-lb. high-vacuum station, may appear in a different light when refigured for twelve-hundred-pounds pressure and a considerably decreased vacuum.

The "necessity" of high vacuum has become such a fixed creed in central-station work that these thoughts are likely to be discarded without a fair analysis, but they require an economic answer, not one based on limitations that have ceased to exist.

In fact, the commercial arrival of high pressures should do much to bring engineers back to the first principles. Low-pressure practice, for example, has little value as a guide to the correct division of heating space among the boiler proper, economizer and air heater of the high-pressure plant. Again, high pressures mean increased importance of economical and reliable feed pumps. Instances might be multiplied, but it is already clear that high pressure demands a new deal all around.



New 50-m.g.d. turbine-driven pump installed at the Ross Pumping Station, Pittsburgh

TURBINE-DRIVEN PUMPS

REPLACE ENGINE-DRIVEN UNITS

In Pittsburgh Pumping Station

THE water supply for the city of Pittsburgh is pumped from the Allegheny River, passed through slow sand filter beds and pumped to various distribution reservoirs. At the Ross pumping station, on the north bank of the Allegheny about six miles from the business district of Pittsburgh, water is pumped from the river to the filtration plant. Thus, all of the water used in the Pittsburgh district passes through the pumping station, and for this reason its equipment has been chosen and installed with reliability a controlling factor.

Until recently, most of the equipment installed when the station was built, was still in operation. The centrifugal pumps, driven by reciprocating engines, were of such old vintage that the bearings were wood lined. These units, though still able to operate, had long outlived their natural life and were ready to be replaced by more modern and efficient equipment.

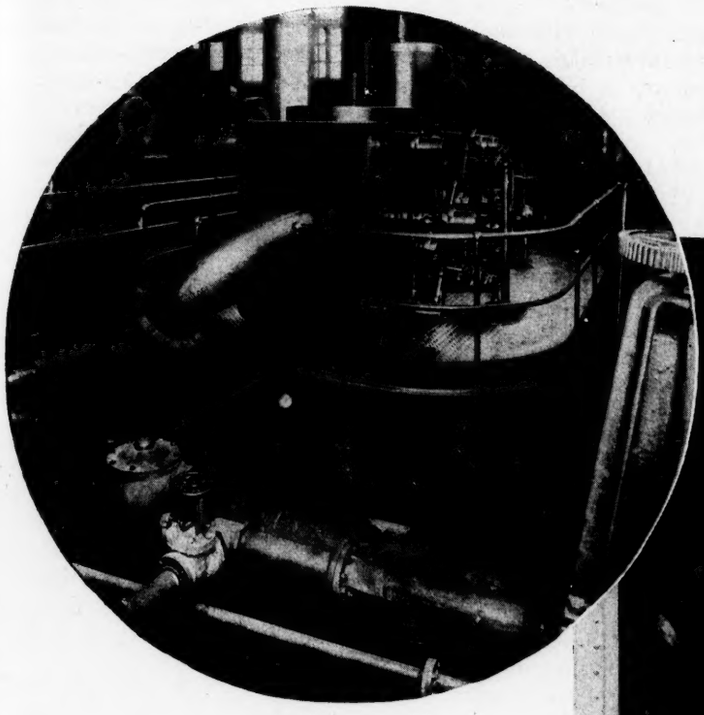
With the advantages of moderately high pressures in mind the engineers decided to replace four of the old 3,500-sq.ft. boilers with two new ones that would generate steam at 330 lb. pressure and 200 deg. superheat. Two of the old engine-driven 35-m.g.d. pumps were replaced by two turbine-driven units, one of 100 m.g.d. and one of 50 m.g.d. capacity. This left in the station two old engine-driven pumps, one of 50 m.g.d. and one of 35 m.g.d. capacity, and a 100-m.g.d. turbine-driven pump that had been installed about fifteen years previously. The new pumping units are capable of handling the entire station load.

As the existing coal-handling system could not be used for the new boilers, a new system was installed. Coal delivered by rail is removed from a track hopper by an apron conveyor to a coal crusher of 40 tons per hour capacity. From the discharge of the crusher the coal is carried in a bucket elevator to the top of a concrete-stave 400-ton storage bunker of the silo type. Crushed coal is discharged from the bottom of the silo through three gates onto a belt conveyor that delivers the coal to a bucket elevator inside the plant. This elevator delivers the coal to two 90-ton cast-iron bunkers from which it falls by gravity to the stoker hoppers.

The new boilers are of the Stirling type, each having 6,000 sq.ft. of heating surface. Steam is generated at 330 lb. pressure and superheated 200 deg. in superheaters each having 810 square feet.

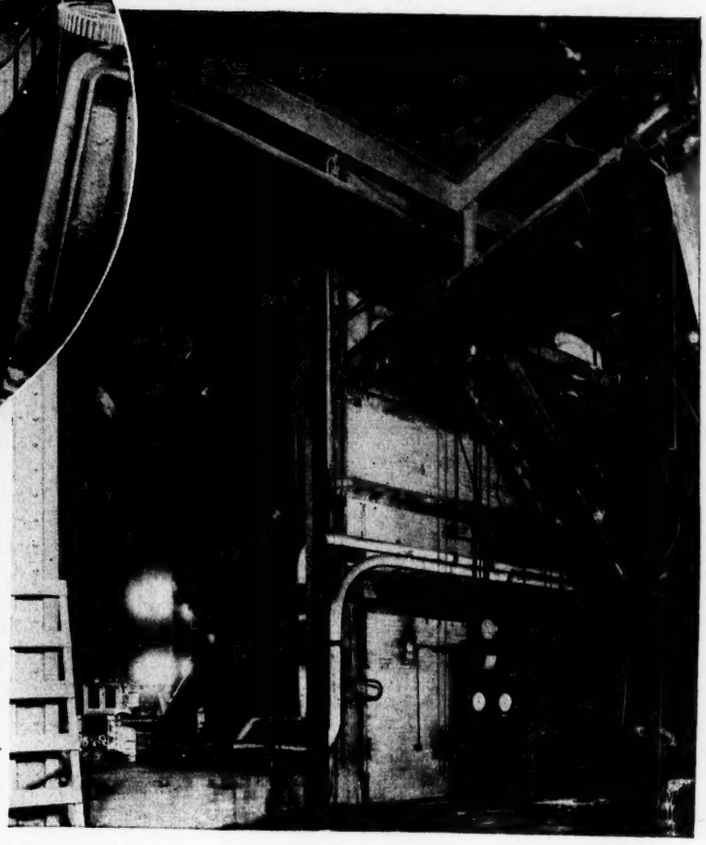
A rear water wall protected by cast-iron blocks and tied in with the boiler circulation, cools the rear furnace wall.

The boilers are fired by six-retort underfeed stokers equipped with power-operated dump grates and designed to operate at 300 per cent rating. They are driven by water turbines, which are supplied with city water under a pressure of 85 to 100 lb. This type of drive, because of its reliability, has been installed, for emergency use

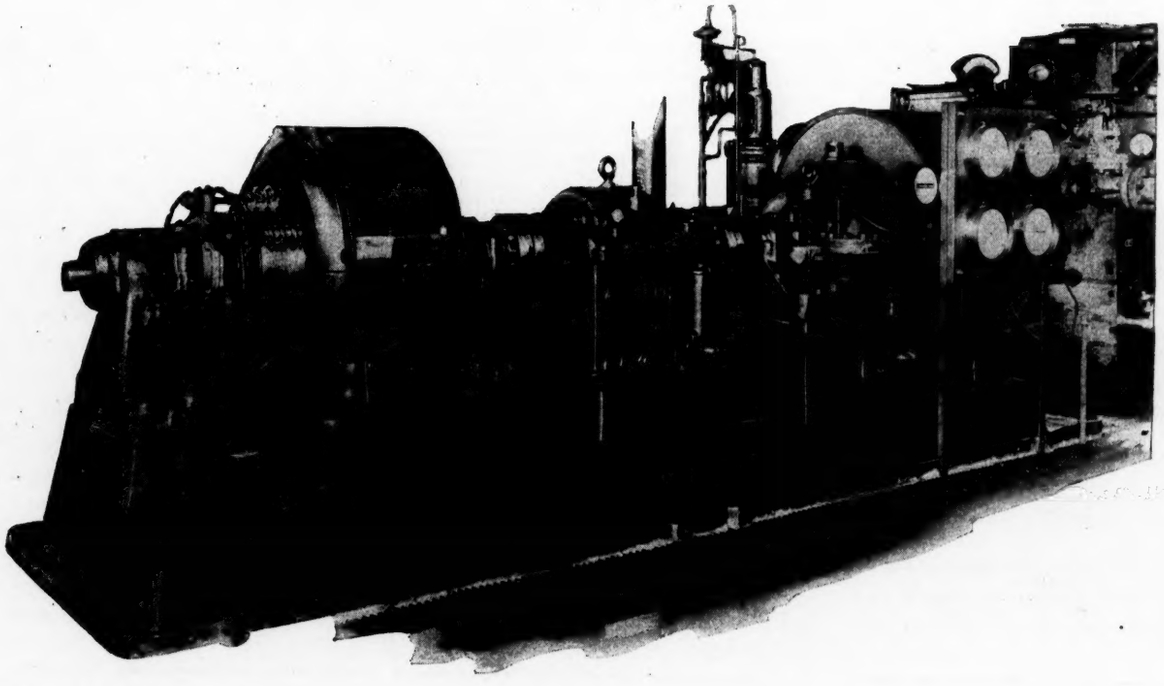


Above — One of the remaining engine-driven pumps. Two units similar to this were replaced by turbine-driven pumps

Below — One of the new boilers. The second unit will be installed in the space now occupied by the old boiler, part of which can be seen at the right of the picture



Below — New 200-kw. turbine-driven generator supplied with steam at 315 lb. pressure. This unit replaced a vertical engine-driven unit of 175-kw. capacity



only, on most of the important plant auxiliaries.

In order to use the present ash tunnel it was found necessary to raise the stoker and floor level 24 in. above the old boiler-room floor. Ashes are wheeled out through this tunnel and elevated to a storage bunker.

For each boiler a forced-draft fan of 18,000 c.f.m.

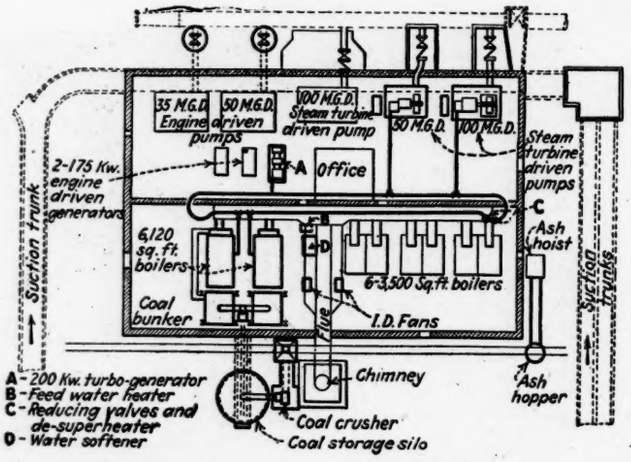


Diagram showing relative positions of the station equipment

capacity, driven by a 45-hp. motor and also by a water turbine through a friction clutch, delivers air for combustion through a plate-type air preheater to the windbox of the stoker. The air preheaters have a heating surface of 5,568 sq.ft. each and are designed to heat the air to 410 deg. at maximum boiler rating. The flue gas makes one pass through the heaters and is delivered to a brick chimney by induced-draft fans. Two fans of 32,000 c.f.m. capacity each, located in the breeching at the center of the boiler-room, handle the flue gas from all the boilers.

Automatic combustion control, boiler meters, temperature recorders and draft gages have been installed to insure efficient boiler operation.

Steam from the boilers is delivered to a 10- and 8-in. diameter loop header. Whenever a connection is made to it, a gate valve is placed in the header on both sides of the connection and also a valve in the branch line. All these valves are motor operated and controlled from a central point in the boiler room.

The main pumping units take water from a suction tunnel that runs the length of the station, the normal water level in the river being seven feet below the center line of the pumps. Both pumps are single-stage and discharge to a 96-in. diameter header against a total head of 57 ft. The 100-m.g.d. pump discharges through a 60-in. diameter check and 48-in. diameter gate valve, the 50-m.g.d. pump through a 48-in. check and a 48-in. gate valve.

Each pump is driven through a reduction gear by an impulse turbine. That driving the smaller unit has a normal rating of 581 hp., runs at 5,580 r.p.m. and drives the pump at 410 r.p.m., whereas that driving the larger unit is rated at 1,200 hp., operates at 5,660 r.p.m. and drives the pump at 340 r.p.m.

Both units are designed for operation with steam at 315-lb. pressure and 200-deg. superheat, and exhaust to

NEW EQUIPMENT IN THE ROSS PUMPING STATION

Coal-Handling Equipment

Steel track hopper, 8 tons capacity.....Link-Belt Co.
Concrete stave silo, 400 tons capacity....Neff & Fry Co.
Bunkers, two cast iron, 70 ton capacity each .....Allen Sherman Hoff Co.
Apron conveyor, two bucket elevators.....Link Belt Co.
One coal crusher, one belt conveyor 40 tons per hour capacity .....Link Belt Co.
Ash-hoppers .....Allen Sherman Hoff Co.

Boiler and Combustion Equipment

Boilers, two, Stirling type, 6,232 sq.ft. 400 lb. pressure .....Babcock & Wilcox Co.
Superheater, two, 810.2 sq.ft., 180 to 230 deg. F. superheat .....Babcock & Wilcox Co.
Rear water wall .....American Engineering Co.
Blowoff valves .....Yarnall-Waring Co.
Copes feed-water regulators....Northern Equipment Co.
Excess pressure regulators.....Mercon Regulator Co.
Soot blowers .....Diamond Power Specialty Corp.
Stokers, two 6-retort, Taylor, power-operated dump grates .....American Engineering Co.
Stoker drive, water turbine.....Worthington Pump & Machinery Corp.
Combustion control .....Hagan Corp.
Air preheaters, two, plate type, 5,568 sq.ft. of heating surface each .....Prat Daniel Corp.
Forced-draft fans, two, 18,000 c.f.m.-10 in S. P. .....Robinson Ventilators Co.
Fan drive, dual ..Worthington Pump & Machinery Corp. water turbine, Crocker Wheeler Co. motor.
Induced-draft fans, two, serve both new and old boilers 32,000 c.f.m., 4.25 in. S.P. ....Robinson Ventilators Co.
Fan drive motor .....Crocker Wheeler Co.

Water Treatment

Water softener, 1,250 gal. per hr. .....American Water Softener Co.
Water heaters, one, open type, 54,000 lb. per hr., 222 deg. F.....Warren Webster & Co.

Generating Equipment

Turbine, one 200 kw. condensing, one-stage bleeding .....Terry Steam Turbine Co.
Generator, one 200-kw. .....Crocker Wheeler Co.

Pumping Equipment

Main pump, one 69,500 g.p.m., 340 r.p.m., 57 ft. head, driven by 1,200-hp., 5,660-r.p.m. turbine through reduction gears.....De Laval Steam Turbine Co.
one 34,750 g.p.m., 410 r.p.m. 57 ft. head driven by 581-hp., 5,580-r.p.m. turbine through reduction gear .....De Laval Steam Turbine Co.

Condensing Equipment & Auxiliaries

Surface condensers, one, three pass, 2,050 sq.ft. .....Elliott Co.
one, three-pass, 1,000 sq.ft.....Elliott Co.
one, three-pass, 263 sq.ft.....Foster Wheeler Corp.
Air Pumps, 4 two-stage steam jet air pumps and condensers .....Elliott Co.
one vertical-duplex, motor driven wet-air pump .....Foster Wheeler Corp.
Condensate pumps, one 79 g.p.m.; one, 63 g.p.m., each driven by Westinghouse motor and water turbine .....De Laval Steam Turbine Co.
Condenser circulating-water pumps, one 10 in.; one 6 in. driven by motor and water turbine .....De Laval Steam Turbine Co.
Boiler-feed pumps, two, 5 stage, 85 g.p.m.; one driven by 3,650 r.p.m. Star motor direct connected, the other driven by Star motor and Worthington water turbine through step-up gear .....Moore Steam Turbine Corp.
Hotwell pumps, two, 75 g.p.m. driven by Star motor. Either pump may be driven by a Worthington water turbine (all direct connected) .Moore Steam Turbine Corp.

Piping and Valves

Piping .....National Valve & Mfg. Co.
Gate valves .....Walworth Co.
Valve control .....Liberty Electric Co
Boiler stop valve.....Edward Valve & Mfg. Co.
Pressure-reducing valves .....Mercon Regulator Co.
Gate and check valves, 48 in. dia...Ludlow Valve Mfg. Co.

Instruments and Miscellaneous

Boiler meters .....Bailey Meter Co.
Temperature recorders .....Bailey Meter Co.
Draft gages .....Bailey Meter Co.
Desuperheater, Cortridge type.....Elliott Co.
Steam separator .....Elliott Co.

surface condensers. The larger unit, however, will drive the pump at 85 m.g.d. capacity when supplied with dry-saturated steam at 150-lb. pressure which is the steam condition carried on the old boilers.

The new 315-lb. steam header is connected to the old 150-lb. station header through two pressure-reducing valves connected in parallel. These valves, of 4- and 5-in. diameter, are followed by safety valves of the same diameter. In order to protect the low-pressure system from the high superheat of the high-pressure system, a cartridge-type desuperheater and separator has been installed.

Previously, steam had been supplied through reducing valves to the filtration plant for building heating. This steam is now bled at 40 lb. pressure from the 1,200-hp. turbine, which is equipped with automatic bleeder control. During severe weather a maximum of 14,000 lb. per hour may be bled from this unit.

Condenser circulating water is normally taken from a settled-water header, which receives its supply from the

Rear view of the station showing coal-storage silo and coal elevators

filtration plant under a head of about 38 ft., therefore pumping is not required. Emergency circulating pumps have, however, been installed.

Condensate pumps, arranged so that they can be driven either by an electric motor or a water turbine, deliver water from the condenser through steam-jet air-ejector condensers to a hotwell tank. All the station drips are also collected in this tank.

From the hotwell tank the water is pumped to a feed-water heater and then fed to the boilers. Two motor-driven hotwell pumps are installed and arranged so that either can be driven by the same water turbine, which is located between them. There are two 85-g.p.m., 5-stage boiler-feed pumps, one of which is driven by motor and the other is provided with a dual motor and water-turbine drive. Makeup water is treated in a softener and introduced into the system at the feed-water heater.

At the same time the new pumping units were installed, one of the old 175-kw. engine-generator sets was removed and replaced by a 200-kw. turbine-generator unit. This left in the station one turbine-generator set in regular operation and two engine sets in reserve.

The new turbine unit is supplied with 315-lb. superheated steam and exhausts to a surface condenser. Steam is bled from the first stage and used in the open heater for heating the feed water.

Space has been left in the station so that, should it prove desirable, additional turbine generators can be installed to supply energy to a near-by high-pressure pumping station.

As the new equipment has only just been put in operation, it is impossible to say what actual saving will result. Undoubtedly, however, the cost of pumping at this station will be greatly reduced because of the more modern equipment now in use.

Power wishes to thank William Shaw, power engineer, Department of Public Works, Pittsburgh, Pa., for his assistance in the preparation of this article.

Factory Application Determines Power-Plant Capacity

By G. Grow

MANY a factory owner could save money if he would have a competent engineer make a study of the power application in his mill. Frequently, the various machines are not properly motored or synchronized in action, so that the size of the power plant is needlessly large, resulting in excessive capital investments and high power costs.

An example of this method of factory working arose some time ago in a Southern mill. Originally, this factory, which made, let us say, furniture, though this is not true, was driven by a 20x42-in. Corliss engine through a system of lineshafts. As the factory increased, new countershafts and belts were added until the engine was just able to struggle along. The steam came from horizontal tubular boilers built for 125 lb. gage, and arranged for hand firing.

Eventually, the owner decided to erect a new mill, for his machinery was getting out of date and competition was keen. The new plant was to have the same output as the old, and the various joiners, planers and other machines were to be motor driven, so an electrical contractor took the job of installing the motors and wiring. When this was about finished, the owner began to wonder if the old engine and boilers would be able to handle load. The electrical man emphatically declared that the old engine could never pull a generator of sufficient capacity for the motors.

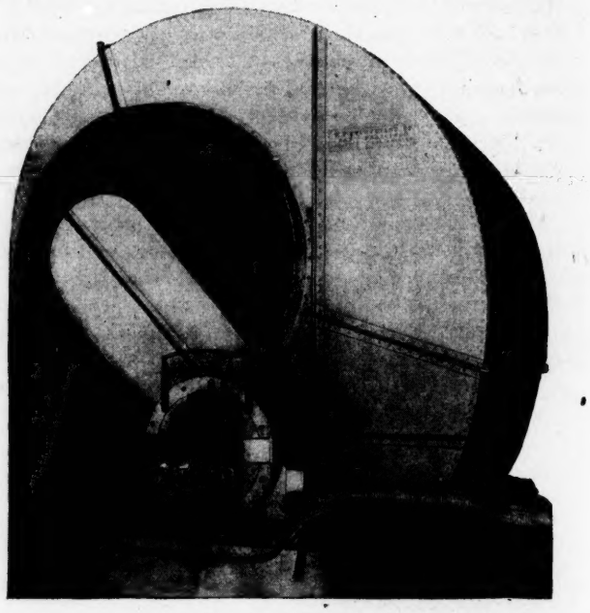
It was a case of either buying a new power plant or arranging to obtain electrical energy from the outside. As there was sufficient wood refuse for fuel, a new power plant seemed to be a more advisable solution, and the owner proceeded to get prices on the equipment he considered necessary to meet the needs of his factory.

Through some unknown influence he asked a mechanical engineer to give his factory an inspection. A survey revealed that every machine was over-motored and that at no time were all the machines in operation. As the motor drive had less losses than had the old lineshaft arrangement, the engineer found that the engine would handle the new mill. This meant a saving of over $10,000. When removing the boilers to the new location, the engineer induced the owner to raise the setting so as to make the furnace height nine feet instead of the former 30 inches. The improved combustion reduced the fuel consumption to the point where there was an excess.

Which story proves the moral that a plant owner should employ a power engineer to study his factory processes, for power and process are so interrelated that one cannot be considered alone.

FOUR-SPEED A.C. MOTORS *Drive Ventilating Fans*

By GEORGE G. LANDIS
Electrical Engineer,
The Lincoln Electric Company



Motors are connected to the fans by silent-chain drive

TO INSURE pure air for the occupants of vehicles traveling through the George A. Posey tube, a million cubic feet of fresh air a minute is forced into this underwater vehicular tunnel, which connects the cities of Oakland and Alameda, California. Mechanically ventilated by what is known as the continuous transverse method, air is supplied by sixteen large fans located in the two portal buildings of the tube.

Before the contract was let for supplying the fan motors, the possibilities of various types of motors were investigated. These included direct-current motors, and squirrel-cage motors of the single-speed, two-speed, three-speed and four-speed types. Slip-ring induction motors, both single- and two-speed types, were also considered.

After a study of traffic operating schedules it was determined that the four-speed, squirrel-cage motor was the most economical for operating the fans. In fact, this type of motor will effect a saving of approximately $7,000 in power for the first year of operation over the variable-speed slip-ring type.

Therefore, a specification was drawn covering the mechanical and electrical details, setting forth minimum efficiencies, starting torques, starting currents, etc. A contract was let to The Lincoln Electric Company for building the 16 motors for driving the fans. These machines have synchronous speeds of 450, 600, 900, and 1,200 r.p.m. The horsepower ratings corresponding to these speeds are 5, 15, 30 and 75, respectively.

The motors are designed for three-phase, 60 cycles, 440 volts. They have two independent stator windings, one in the bottom of the stator slots and one in the top. Each of these windings is provided with middle taps that permit parallel connections, making possible the four speed combinations. The rotor bars are arc welded to copper end rings, and blower vanes are arc welded to the rotor structure at both ends for ventilating purposes. The motor frames and end housings are of rolled steel, fabricated by the electric-arc welding process. Sleeve-type bearings with oil rings are used.

Sixteen 75-hp. squirrel-cage motors designed for speeds of 450, 600, 900 and 1,200 r.p.m. are used to drive fans to ventilate the vehicular tunnel between Oakland and Alameda, Calif. This design of alternating-current motor will save approximately $7,000 per year in power costs over other types.

A tachometer generator is operated from each motor. This generator is connected to an indicator and recorder in the control room. These show the operator at what speed the fans are operating. A flyball governor is also driven by each motor. This governor will, at any speed below 400 r.p.m., close a damper between that fan and the air ducts. This is to prevent the air from other fans blowing back and running the fans that are shut down backward.

The motors are controlled either manually or automatically. The automatic control is worked off a monoxide recorder. When the air in the tunnel has more than a given amount of carbon monoxide gas in it, the fan motors are automatically switched to a higher speed.

When the motors are started on the 5- or the 15-hp. windings, they are started on full line voltage. Starting on the 30- and the 75-hp. winding is done on reduced voltage, which is obtained through resistance. The resistance grids are mounted on top of the control boxes.

When slowing down from one speed to another, in order to avoid too fast retardation of the fan, a time element is introduced into the control. This time is adjustable and allows the motor to slow down to approximately the next lower speed before connecting it to the line.

Extensive tests were conducted on these motors at the manufacturer's plant before they were shipped for installation. These tests were observed and certified by a national testing laboratory.

Tests were made of each of the sixteen motors for resistance of windings; no load (running) saturation test; locked-rotor saturation test; high-voltage test; insulation-resistance test; and check of the air gap. Additional tests were made of a typical motor selected at random from the sixteen. These tests included a temperature run at rated load on the 75-hp. winding for 24 hours; 1¼ load on the 75-hp. winding for two hours immediately following the preceding test; also 1¼ load on the 30-, 15- and 5-hp. windings for a period or two hours each.

Another test was load runs on each of the windings at approximate loads of 1¼, 1, ¾, ½ and ¼ of rated value. Check tests were also made by a dynamometer of as many of the load runs made in the preceding test as could be obtained. All tests were conducted according to standard approved methods, using those specified by the American Institute of Electrical Engineers wherever they were designated.

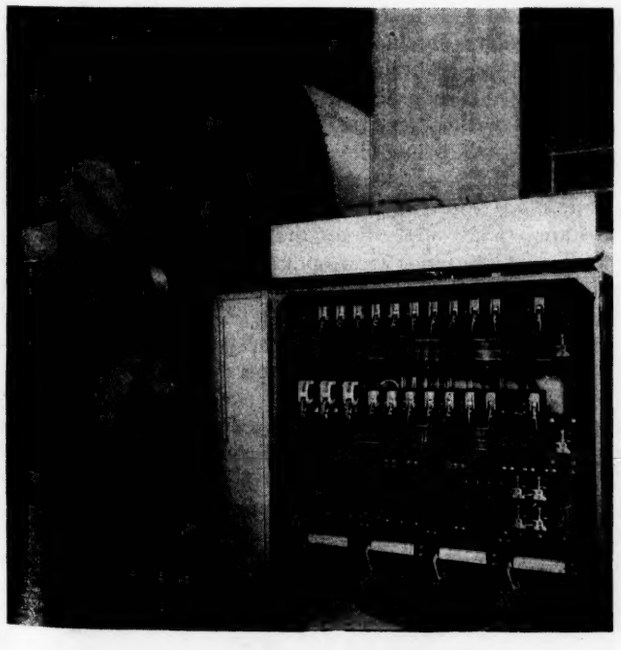
Tests Made of Each Motor

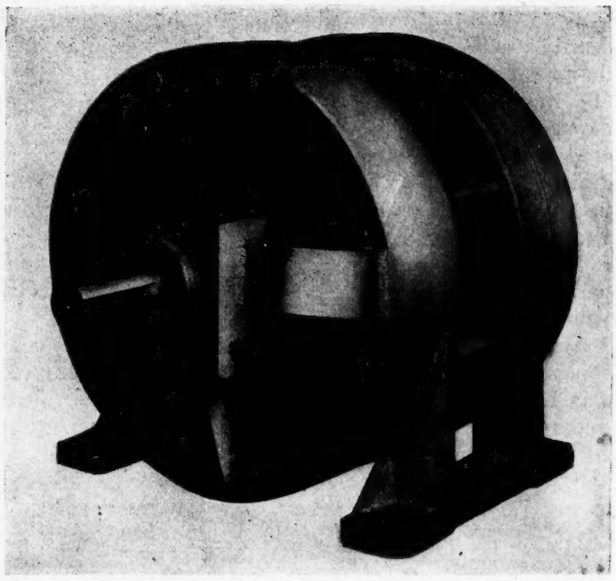
Winding resistances were measured by the fall of potential method using direct current, readings being taken with a calibrated ammeter and voltmeter. The currents used were sufficiently small to avoid appreciable heating.

The no-load saturation test was made by observing the current and power input to the motor with various values of applied voltage with the motor running free. The five voltages selected for this test were approximately 600, 440, 320, 220 and 110 volts, respectively. Previous to taking the readings of the running saturation, each motor was operated at rated voltage and no load for not less than one hour in order that the bearing-friction loss might attain constant values. The stator core was therefore warm at the time of the measurements, but the temperature rise of the windings was inappreciable.

Motors may be controlled automatically or manually

The automatic control is worked off a monoxide recorder. When the monoxide gas in the air in the tunnel increases above a given amount, the fan motors are automatically switched to a higher speed. Full-voltage starting is used on the two low-speed windings and when starting on the high-speed winding reduced voltage is applied.





The motor frames and end housing are of rolled steel fabricated by the arc-welding process

In the locked-rotor saturation test, rotation was prevented by means of a brake arm keyed to the shaft of the motor. The brake arm was supported in a horizontal position by means of a chain hoist, and the static torque developed was measured by a spring balance. Two test voltages for each winding were adopted as standard values. In the case of the 75-hp. and 30-hp. windings the maximum test voltage was one-half of rated. On the other two windings it was possible to apply rated voltage.

The high-voltage test was made by applying 2,500 volts at 60 cycles between the two stator windings. Then this voltage was applied between the stator winding, in the bottom of the slots, and the frame. The voltage was applied at a low value and raised by steps to the desired amount, at which point it was maintained for one minute. The standardization rules of the American Institute of Electrical Engineers call for a test voltage of 1,880 volts for a 440-volt motor. The absence of fine regulation of the voltage supplied prevented testing at this value, and with the consent of the manufacturer a higher test voltage was used.

Insulation-Resistance Tests

The insulation resistance between the two windings and the windings and frame was measured by means of an ohmeter with a graduated slide wire, operating on the Wheatstone Bridge principle. The test was made with 90 volts and with the motors cold.

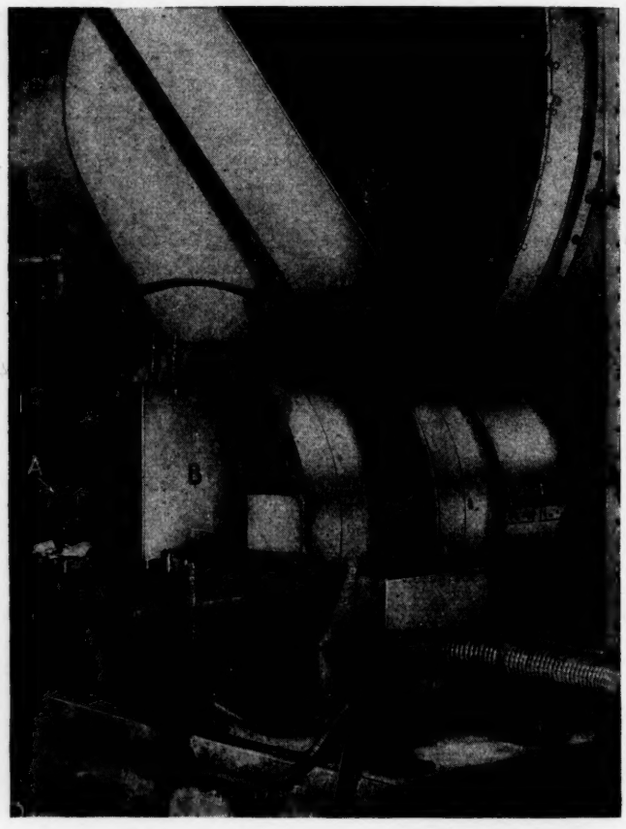
Standard air-gap gages were used to measure the length of the air gaps between the rotor and stator cores. The measurements were made at four points, the centers of each of the four quadrants. The gages were run through from end to end of the gap in every case.

The motor selected for the tests made on a typical motor was belted to a slip-ring induction generator connected to return current to the supply circuit. The motor load was adjusted by means of a three-phase rheostat in the secondary circuit of the generator.

In the temperature tests mercury thermometers were placed at three points on the stator iron, one in the ventilating duct, at two points between the coils of the high-

speed stator winding (which was in the bottom of the slots and therefore, was the outer surface), and in both bearings. A thermometer was also hung in the air near the motor and another was attached to one of the fifteen idle motors standing near-by. The bulbs of all thermometers, except the one hanging in the air, were covered with a small amount of putty to hold them in the desired positions and to protect them against radiation losses. The load conditions were quite unsteady and care was therefore taken that the motor was operating in every case at a load above the desired value. The temperature rises obtained therefore represent the maximum value.

Since it was not advisable to leave all the instruments continuously in circuit, a recording polyphase wattmeter was left in the circuit to show the input to the motor under test. The indication of the recording wattmeter corresponding to the desired input was determined by



Each motor has an electric tachometer A and a flyball governor B attached to it

An electric tachometer driven by the motor indicates and records the fans speed in the control room. A flyball governor driven by the motor closes a damper between that fan and the air duct at speeds below 400 r.p.m. This is to prevent air from other fans blowing back and running the fan backward when it is shut down.

means of the calibrated instruments, and this indication was maintained thereafter as a minimum reading of the load.

Readings of the thermometers and of the graphic wattmeter were taken at intervals of one-half hour during the first four hours of the 24-hour test, after which readings were taken at intervals of about two hours until 24 hours had elapsed. At the end of this time the motor was disconnected from the source of supply and the resistance of the stator windings was obtained by the fall of potential method as quickly as possible. The resistance measurements were made on both windings, although only one of them had been carrying current. At the same time that the resistance measurements were being made, thermometers were placed on the rotor to observe its temperature.

When the resistance and temperature measurements at the end of the 24-hour heat run had been completed, the motor was again started. A load equal to 1½ times rated value was applied for a short time until the readings of the thermometers placed on the motor showed that the temperatures had returned to the values obtaining at the end of the 24-hour heat run. Beginning at that time, a load equal to 1¼ times rated values, or about 94 hp., was applied and maintained for two hours. As before, the indication of the graphic wattmeter corresponding to the desired load was determined by reference to the standardized instruments and this indication was maintained thereafter.

Temperature readings were taken during this run at intervals. At the expiration of the testing period the motor was shut down and resistance and temperature readings were taken as before.

A similar procedure was followed in applying a test at 1¼ times rated load to each of the remaining three winding combinations corresponding to the ratings of 30, 15 and 5 hp. In each case an overload was applied for sufficient length of time to bring the thermometers on the motor to the indications corresponding to the temperatures obtained in the 24-hour test on the 75-hp. winding. Resistance and temperature readings were made at the end of each run.

In the load tests the generator regulating resistance was adjusted to produce loads ranging from 1¼ times nominal to ¼ times nominal, for each of the four stator combinations. Input readings of volts, amperes, power and reactive volt-amperes were observed in each test. A simultaneous determination of the slip of the rotor was made with the aid of a stroboscope. For each winding combination the test at 1¼ times rated load was made first, the others following, so that the motor was tested at temperatures corresponding approximately to working conditions.

Dynamometer Test Made on a Selected Motor

A dynamometer test was made on a selected motor as a check on the values of efficiency obtained by computation from the results of the load test and loss measurements previously described. The dynamometer consisted of a direct-current generator with separately excited field, mounted in a cradle on ball bearings and provided with a sensitive lever system for the measurement of the torque developed. The motor under test was connected to the generator by means of a flexible coupling. The power developed was absorbed in a resistance load applied to the direct-current generator. Sufficient readings were obtained to serve as a check of the values of efficiency obtained by the summation-of-losses method.

The results of these tests proved that the motors more than satisfied the exacting specification requirements. The building of the motors and their testing is indicative of the careful engineering procedure which marked the construction and equipping of the tube and to which must be attributed the successful completion and operation of the West's first underwater vehicular tunnel. In this case the four-speed alternating-current motors have been applied to driving fans for tunnel ventilation; however, they may be used for any fan application where a wide range of speed is required.

A coke plant of moderate size suitable for use in combination with power generating stations

Can Cheaper Power Be Obtained
BY PRETREATING COAL?

Eight Studies of Differing Combinations Show What the Possibilities Are

By Walter R. Knapp and Paul McMichael

Respectively, of E. L. Phillips Company, New York City, and Consulting Engineer, New York City

NUMEROUS claims have been made as to the possibilities of reducing the cost of generating electric energy through a decrease in cost of boiler fuel by processing coal with a recovery of byproducts. It is self-evident that the cost of boiler fuel can be decreased by processing the coal only if the revenue derived from the sale of byproducts is greater than the costs of conversion. Undoubtedly, a heat unit in the form of gas is more valuable for firing boilers than a heat unit in solid form; but for gas firing to be profitable the net cost of the gaseous heat unit cannot much exceed that of the solid.

To determine the possibilities of generating electric energy more cheaply, eight studies were made to discover how different types of gas plants, variously operated, in combination with a steam-electric generating station compare as to investment and operation cost with a modern coal-fired steam-electric power plant (actual figures from the Toronto station of the Ohio River Edison Company were used).

Beyond the fact that the power generating plant shall be located favorably with respect to coal and water, we have considered no particular locality, but have assumed a district capable of consuming the output of a 150,000-kw. plant operating with an average load factor of 60 per cent. Power consumption per capita varies widely, from a minimum of about 500 kw.-hr. per year to a maximum of about 1,500, with an average of about 1,100.

As with electricity the gas consumption in any given district is a function of many varying factors and does not necessarily parallel that of power. Consequently, without having a definite district designated, it is impossible to determine the relative loads for electricity and gas. However, it appears that in the average American community approximately 10 cu.ft. of gas is distributed for every kilowatt-hour of electricity consumed.

The principal markets for coke are for foundry and blast-furnace use, water-gas manufacture and the domestic trade. The demand for metallurgical coke is a direct function of the prosperity of the country, and so fluctuates widely. The demand for power is not affected to so marked a degree by business conditions. Therefore it would be unwise to have the economic future of a power plant dependent upon the marketing of a product subject to such wide fluctuations in demand.

The market for coke for water-gas manufacture is relatively small and cannot be depended upon as an outlet for the entire production of coke from such plants as described in this report.

The domestic coke market is not much affected by the

general business conditions of the country. While there may be minor fluctuations, the general trend from year to year is toward a broader market for this satisfactory smokeless fuel. This, together with the fact that domestic coke does not require as careful preparation as metallurgical coke, makes it the desirable product to manufacture for sale in a combined gas-electric plant.

On account of the wide fluctuations in the per capita consumption of electricity for power in different communities, it is impossible to establish any very definite ratio between its total consumption and the consumption of domestic fuel. While data are available as to the total consumption of electricity in some definite areas, similar data for the same areas on the consumption of domestic fuel are not available. However, data are obtainable from which generalizations may be drawn.

From widely varying ratios we deduce that the solid domestic fuel consumption in a district is about 0.002 ton (4 lb.) per kw.-hr. However, even with this high ratio of consumption it is found that the entire requirement of solid domestic fuel in the area of power distribution is barely sufficient to absorb all the coke produced in a combined byproduct coke oven power generating station. As it is improbable that coke can entirely displace other solid domestic fuels already in use, even with extreme price concessions, it is self-evident that outside markets must be developed for the disposal of a considerable part of the coke production.

Markets for Byproducts

Ammonium sulphate has a well established market as a fertilizer element and is the base for the manufacture of other ammonium compounds. Its consumption in the fertilizer industry is increasing more rapidly than its production in byproduct coke oven plants, the demand being met more and more from synthetic ammonia plants. In these studies the maximum production contemplated is only a small part (not exceeding 5 per cent in any case) of the total from all byproduct coke oven plants in the country, so it should be marketable without difficulty at standard prices through established channels.

Coke-oven tar also has a well established market, being the raw material for the manufacture of many products. The creosote oils are used principally as wood preservatives and the pitch and heavy oils for road building. Here, as in the case of the ammonium sulphate, owing to the relatively small amount produced there should be no difficulty in disposing of the entire production at standard market prices.

Low-temperature and water-gas tar have not as well established markets, and there will be greater difficulty in disposal than with coke-oven tar without marked price concessions.

Refined light oils are used as solvents in many industries and as bases for numerous chemical products. In excess of these requirements light oil is used in the preparation of anti-knock motor fuel.

The plant scheme selected for study has an installed capacity of 150,000 kw., consisting of three multi-stage condensing turbine-generating units.

The steam equipment consists of six 21,000-sq.ft. boilers which furnish steam at 600 lb. and 725 deg. F. The feed-water makeup from single-effect evaporators, together with the turbine condensate, is preheated to 360 deg. F. in two open-type and one closed-type heaters with steam bled from the turbines. The temperature of the stack gases leaving the economizers is 300 deg. F.

The solid fuel is delivered by belt through a rough crusher to the raw coal bunker bins. From the bunker bins the crushed fuel is discharged to driers, then to unit pulverizers and thence through a cyclone separator to the burners. Each boiler has its own drier, mill and separator, but by means of screw conveyors the pulverized fuel can be diverted to another boiler.

The building is of modern type. The entire generating station and the outdoor step-up substation are operated from the central electrical control room.

When the power-generating plant is gas-fired, the power units remain the same as in the coal-fired installation except as to coal-handling equipment, including belts, bins, crushers, driers, pulverizers, separators and pulverized-fuel burners and forced-draft equipment, all of which are omitted. For gas firing, simple Bunsen-type burners are installed. These require no forced-draft equipment, as the stack draft will supply sufficient air for the combustion, which will take place in checker brick in the furnace. No change has been made in the building or in the boiler settings.

For the coke-oven installation the modern regenerator type of oven has been used. The ovens have a capacity of 14.31 tons of coal per charge, and when operated at full capacity have a throughput of 28.62 tons per day.

The byproduct equipment is of sufficient size to handle all the products when the ovens are operated at maximum speed. In all cases tar, light oil and ammonium sulphate are recovered. Sufficient storage capacity is provided for these products to insure economical marketing.

The gas-handling equipment is varied to meet the conditions in each case. When the gas is sold, sufficient purifying equipment is provided to meet the maximum demand load, together with the necessary mixing devices to reduce the calorific value of the gas to the desired standard. Sufficient holder capacity also is installed to meet the varying load conditions of gas sales and to cover any inequalities in production.

Gas as Fuel Allows Saving in Boiler Cost

With the use of gas as boiler fuel no purifying or mixing equipment is provided, but sufficient holder capacity is supplied to meet maximum daily and weekly peak-load requirements in the generating unit and to cover any inequalities in gas production.

Blue-gas equipment is proided as auxiliary to the oven equipment where necessary.

The coal-handling equipment is varied to meet the conditions. The coke-handling equipment also is varied to meet the conditions.

In all installations sufficient dry quenching equipment is provided to handle the maximum coke production. No extra boilers are provided, as the dry quenching equipment furnishes sufficient steam to meet all steam and power requirements of the oven plant.

The blue-gas generators provided are of two types:

(*a*) When the blue gas is used primarily to underfire the ovens or to mix with the oven gas for sale, the equipment consists of the most modern type of eleven-foot, three-shell machines equipped with automatic control, mechanical stokers and grates. Sufficient scrubbing and condensing equipment is provided to assure clean gas. Relief holders are provided of sufficient size to protect the fuel requirements of the ovens.

(*b*) When the gas produced is used as boiler fuel, the equipment consists of an adaptation of the single-shell generator. Like the three-shell type these also are equipped with all modern improvements except waste-heat boilers. When coke is used as fuel no scrubbing or

condensing equipment is provided, both the blue gas and the blast gas being conducted hot direct from the generators to the burners at the boilers. Where a portion of this blue gas is used for admixture with oven gas for sale, it is admitted to the foul gas main in the oven plant ahead of the condensers. The coke-handling equipment is similar to that described under (*a*). No relief holders are required or provided for.

The complete-gasification units considered in this study are of the retort type employed by Bussey at Louisville, Ky., and by Maclaurin at Glasgow, Scotland; but modified in design so that complete gasification results, as in the modified Mond producer.

The operation of the retort is continuous, coal being introduced at the top at the rate of 25 tons a day and ashes being removed at the bottom directly into cars. The blast air is introduced into the ash bed, and steam

TABLE I—YIELDS USED IN ESTIMATING

Products	Quantity per Ton Coal Processed
Coke, lb.	1,300
Breeze, lb.	140
Ammonium sulphate, lb.	25
Light oil, gal.	3
Coke-oven tar, gal.	10
Water-gas tar, gal.	20
Low-temperature tar, gal.	27
Total oven gas, cu.ft.	11,082
Oven gas to underfire ovens, cu.ft.	4,182
Surplus oven gas, cu.ft.	6,900
Blue gas from coke, cu.ft.	41,143
Blast gas from coke, cu.ft.	41,142
Blue gas from coal, cu.ft.	57,143
Blast gas from coal, cu.ft.	57,143
Retort gas, cu.ft.	92,800

is introduced at different levels into the incandescent coke. The hot blast (producer) gas and blue gas pass up through the down-coming coal stream, thereby driving off the volatile matter and converting the coal to coke, the coke being reacted upon in the lower section of the retort, first by the steam and then by the blast, until only ashes remain.

The products of the complete gasification (blast gas, blue gas and carbonization zone gas) leave the top of the retort and are handled in standard condensing and scrubbing equipment for the recovery of light oil and tar before they are fired under the boilers.

The coal-handling equipment is very simple, consisting only of track hoppers and skip hoist with no crushing, disintegrating or screening equipment.

All values used have been conservatively estimated from known operating results obtained in the industries from high volatile coal, as shown in Table I.

Three cases have been considered where the sale of gas enters into the cost of power.

In Study No. 1 only the surplus oven gas, amounting to 6,900 cu.ft. per ton of coal carbonized, is available for sale. After mixture with stack gas to reduce its calorific value to the desired standard, the total volume available is 7,160 cu.ft. The ovens are considered as operated in parallel with power production, and so the greatest gas production is during the period of peak demand for both electricity and gas. With a plant thus operated the oven gas furnishes the same proportion of the gas load of the district throughout the year, the proportion in this case being 52 per cent. As a fair market value for the gas we have used 30c. per thousand cubic feet at the plant. The annual revenue amounts to $1,232,961, or $0.00156 per kw.-hr. produced.

In Study No. 2 the entire production of oven gas, amounting to 11,082 cu.ft. per ton of coal carbonized, is available for sale. After mixture with 300-B.t.u. blue gas from coal to reduce its calorific value to the desired standard, the total volume available is 12,046 cu.ft. Here, as in the previous case, the ovens are considered as operated in parallel with power production, and the maximum gas production is during the period of peak demand for both electricity and gas, which run parallel. With a plant thus operated the oven gas furnishes the same proportion of the gas load of the district throughout the

TABLE II—QUANTITIES USED

	Quantity per Ton Coal Processed
To Carbonise Coal in Ovens	
B.t.u.	2,300,000
Oven gas to underfire ovens, cu.ft.	4,182
Blue gas from coal to underfire ovens, cu.ft.	7,667
Blue gas from coke to underfire ovens, cu.ft.	7,931
To Dilute Total Oven Gas	
Blue gas from coal, cu.ft.	964
To Dilute Surplus Oven Gas	
Stack gas, cu.ft.	260
Blue gas from coke, cu.ft.	575
Water Gas Manufacture	**Quantity per MCF Produced**
Coke, lb.	35
Coal, lb.	35
Steam, lb.	36.85

year, about 88 per cent. The total revenue from gas amounts to $2,074,336, or $0.00263 per kw.-hr. produced.

In Study No. 6 only the surplus oven gas (6,900 cu.ft. per ton of coal carbonized) is available for sale. After mixture with 290-B.t.u. blue gas from coke to reduce its calorific value, the total volume is 7,475 cu.ft. In this study the ovens are considered as operated at maximum speed throughout the year, and consequently produce the same quantity of gas daily, this quantity being the minimum amount required by the district on any day during the year. Hence the oven gas supplies the base load of the district, about 63 per cent of the annual consumption. Here, as in the two previous cases, the value of the gas is taken as 30c. per thousand cubic feet. The annual revenue amounts to $1,482,952, or $0.00188 kw.-hr. produced.

Two cases have been considered where the sale of coke enters into the cost of power:

In Study No. 3 the domestic coke production closely approximates the entire solid domestic fuel requirement

TABLE III—CALORIFIC VALUES

	B.t.u.
Coal at Toronto and into retorts, per lb.	12,300
Coal into ovens and generators, per lb.	13,900
Coke as produced, per lb.	13,200
Breeze as produced, per lb.	12,900
Tar (oven, water, gas and low temperature), per gal.	145,000
Light oil, per gal.	135,000
Oven gas as produced—standard conditions, per cu.ft.	550
Oven gas as sold—standard conditions, per cu.ft.	530
Blue gas from coal—standard conditions, per cu.ft.	300
Blue gas from coke—standard conditions, per cu.ft.	290
Blast gas—standard conditions, per cu.ft.	81.5
Retort gas—standard conditions, per cu.ft.	206.5

of the district supplied by the power plant; and so, as a large proportion will have to be disposed of in outside markets requiring a freight haul, $4 per ton has been considered a fair price at the ovens when raw coal costs $2.65 a ton. With this price of $4 a ton the coke, after leaving the plant, bears all costs incidental to its sale, the differential between coal and coke, dealer's margin, sales expenses and freight. With a production of 1,349,450 tons the annual revenue is $5,397,800, or $0.00684 per kw.-hr. produced.

In Study No. 4 the quantity of domestic coke to be sold is reduced slightly as compared with the previous case, but still leaves more than can be absorbed in the district supplied with power. Here again, the fair price for the coke has been taken as $4 per ton at the ovens. With a production of 1,144,304 tons the annual revenue is $4,577,216, or $0.00581 per kw.-hr. produced.

The sale of ammonium sulphate enters into the cost

of power wherever a byproduct coke oven plant enters into the study, or in six of the set-ups, two of which are identical as to the quantity of coal carbonized in the ovens.

Ammonium sulphate has a present actual market value of more than $40 a ton, but in consideration of the prospective large increase in synthetic ammonia production we have estimated the fair return for ammonium sulphate as $30 per ton at the ovens.

The annual revenue derived from the sale of ammonium sulphate in the five cases and the revenue per kilowatt-hour produced are given in Table IV.

TABLE IV—REVENUE FROM AMMONIUM SULPHATE

Boiler Fuel	Annual Revenue	Revenue per Kw.-Hr.
Coke and breeze	$215,252	$0.00027
Oven gas and breeze	778,529	.00099
Oven gas	738,324	.00094
Oven, blue and blast gases	203,330	.00026
Blue and blast gases	247,985	.00031

The sale of tar is a factor in the cost of power in all cases studied. The market for byproduct coke oven tar has been gradually strengthening, with every indication that its price will be still higher in future. On this account we have taken the present market value of six cents a gallon as being a fair return for the tar at the ovens. The market for water-gas and low-temperature tars is not as well developed as that for coal tar, but all indications are that these will follow the market trend of coal tar, especially because they contain phenolic components required in the manufacture of synthetic resins, such as Bakelite. However, we believe that a differential should be established and consider five cents a gallon at the plant a fair market value for this class of tars. The annual revenue derived from the sale of tar and the revenue per kilowatt-hour produced are given in Table V.

TABLE V—REVENUE FROM SALE OF TAR

Boiler Fuel	Kind of Tar	Total Revenue	Revenue per Kw.-Hr.
Pulverized coke and breeze	Coal	$344,402	$0.00044
Pulverized coke and breeze	Coal and water gas	431,098	.00055
Oven gas and breeze	Coal	1,245,646	.00158
Oven gas	Coal	1,181,319	.00150
Oven, blue and blast gases	Coal	325,328	.00041
Blue and blast gases from coke	Coal	396,776	.00050
Blue and blast gases from coal	Water gas	547,300	.00069
Retort gas	Low-temperature	890,120	.00113

The sale of light oil is a factor in the cost of power in all cases studied except where the coal is processed in generators. The present market value of crude light oil varies between ten and thirteen cents a gallon, depending on whether the district where it is produced is near a market for "pure" products. The prospects are that the demand for light oil will increase more rapidly than production, but nevertheless we have placed the conservative value of ten cents a gallon at the plant as a fair market value for this product. The annual revenue derived from the sale of crude light oil and the revenue per kilowatt-hour produced is as shown in Table VI.

Consider a theoretical 150,000-kw., 600-lb. pressure, straight steam plant using pulverized coal such as is now being consumed at Toronto station. This theoretical plant is manned and operated in accordance with the known conditions in the existing 105,000 kw., 400-lb. pressure, straight steam plant at Toronto, Ohio. To arrive at the cost of power, 15 per cent of the capital investment is taken to cover depreciation and fixed charges. A working capital account is set up for moneys invested in stocks of coal, payroll and plant charges for a sixty-day period, and in the miscellaneous store of repair parts and supplies, 10 per cent of the aggregate value of these items being taken as a fair charge for interest and depletion. The coal cost is taken at $2.15 per ton, the actual weighted average cost at Toronto station for the year 1927. With these conditions the net cost of power generated, not including any distribution cost, is calculated as $0.005215 per kilowatt-hour.

TABLE VI—REVENUE FROM SALE OF LIGHT OIL

Boiler Fuel	Total Revenue	Revenue per Kw.-Hr.
Pulverized coke and breeze	$172,201	$0.00022
Oven gas and breeze	622,823	.00079
Oven gas	590,660	.00075
Oven, blue and blast gases	162,664	.00021
Blue and blast gases from coke	198,388	.00025
Retort gas	197,804	.00025

Consider an identical straight steam plant using Pittsburgh seam coal, suitable either for steam generation or for byproduct coke ovens or water-gas generators. Under the same conditions as before, but with the coal costing $2.65 a ton, the net cost of power is calculated as $0.005298 per kilowatt-hour.

These two cases are considered typical of the cost of generating power in the modern-type straight steam plant, no account being taken of distribution costs or of profit accruing to the investment.

In the first study, where a coke-oven plant is combined with the power generating station, the basis is the sale of the surplus oven gas and the consumption of the resultant coke and breeze as pulverized fuel under the power-plant boilers. A soft, friable coke is produced from the crushed run-of-mine coal. This coke is easily pulverized and does not give as much trouble as coal in obtaining uniform distribution at the burners. It is slightly more difficult to obtain uninterrupted perfect combustion of this fuel, but quite possible in modern

TABLE VII—SUMMARY COST OF POWER IN 150,000 KW. PLANT—CAPACITY USE 60 PER CENT

	Steam Generated With — Pulverized Coal — Low-Grade Coal	High-Grade Coal	Pulv. Coke and Breeze — Surplus Oven Gas Sold	Total Oven Gas Sold	Surplus Oven Gas and Pulverized Breeze	Total Oven Gas	Products of Complete Gasification — Surplus Oven Gas, Blue and Blast Gases	Blue and Blast Gases from Coke	Blue and Blast Gases from Coal	Retort Gas
Capital Investment:										
Power plant	$17,073,000	$17,073,000	$17,073,000	$17,073,000	$17,073,000	$15,500,000	$15,500,000	$15,500,000	$15,500,000	$15,500,000
Gas plant	.....	.....	4,600,000	5,607,000	17,500,000	21,600,000	4,400,000	5,400,000	2,200,000	1,700,000
Total	$17,073,000	$17,073,000	$21,673,000	$22,680,000	$34,573,000	$37,100,000	$19,900,000	$20,900,000	$17,700,000	$17,200,000
Cost per Kw.-Hr. Produced—Mills										
Oper. labor, maint. and supplies	0.595	0.595	1.257	1.460	2.434	2.728	1.792	2.102	1.612	1.161
Interest and depletion	0.048	0.049	0.120	0.149	0.365	0.212	0.103	0.150	0.085	0.088
Fixed charges, 15 per cent	3.248	3.248	4.124	4.315	6.578	7.059	3.786	3.976	3.367	3.272
Coal	1.324	1.406	1.929	2.221	6.978	6.618	1.822	2.222	1.840	1.798
Total operation expense	5.215	5.298	7.430	8.145	16.355	16.617	7.503	8.450	6.904	6.319
Revenue from byproducts	.....	.....	2.492	3.669	10.204	8.990	0.876	2.950	0.694	1.380
Net operation expense	5.215	5.298	4.938	4.476	6.151	7.627	6.627	5.500	6.210	4.939
Change in cost of power—mills	.....	—0.083	+0.277	+0.739	—0.936	—2.412	—1.412	—0.285	—0.995	+0.276
Additional investment										
Gross amount	.....	.....	$4,600,000	$5,607,000	$17,500,000	$20,027,000	$2,827,000	$3,287,000	$627,000	$127,000
Change in cost of power	.....	—$5,749	+$218,644	+$582,927	—$738,009	—$1,901,591	—$1,113,561	—$224,916	—$784,518	+$217,321
Per cent return on add. investment	.....	.....	4.75	10.38	.....	.....	.....	.....	.....	171.12

type furnaces equipped with the proper burners.

To arrive at the cost of power generated, the same set-up is used as that for the theoretical straight steam plant, with the addition of a charge in the working capital account for byproducts carried in stock or as bills receivable for a sixty-day period. A credit at fair market value is taken for the byproducts—gas, ammonium sulphate, tar and light oil. Pittsburgh seam coal is carbonized in the ovens, its cost being $2.65 a ton delivered.

The second study, where a coke-oven plant is combined with the power generating station, is predicated upon the sale of the total gas production of the ovens, this necessitating underfiring the ovens with auxiliary fuel (blue gas made from coal) and the consumption of the resultant coke and breeze as pulverized fuel under the power-plant boilers.

The third study, where a coke-oven plant is combined with the power generating station, is predicated upon the sale of the coke production as domestic fuel and the burning of pulverized breeze and surplus oven gas under the power-plant boilers.

The fourth study, where a coke-oven plant is combined with the power generating station, is predicated upon the sale of the net coke production as domestic fuel and the burning of the total oven gas under the power-plant boilers, the ovens being underfired with auxiliary fuel, that is, with blue gas made in generators from a portion of the coke and all the breeze from the ovens.

The fifth and subsequent studies are predicated upon the complete gasification of the coal by means of ovens and generators, or generators, or retorts as indicated.

In the fifth study the coal is carbonized in a byproduct coke oven plant, which, when operated at 100 per cent rating, has a capacity in coke and gas equivalent to the annual fuel requirement of the power generating station. The surplus gas production is continuously consumed under the power-plant boilers and the coke and breeze production is gasified as needed in blue-gas generators, which have a capacity equal to the fuel requirements of the power plant when operated at 100 per cent load factor.

The sixth study is the same as the fifth except that, instead of burning the surplus oven gas under the power-plant boilers, it is sold as the base load of the local distributing companies.

In the seventh study a blue-gas generating plant is the medium utilized for the complete gasification of the coal. In this the only byproduct recovered is water-gas tar, all other products of the coal conversion being consumed under the power-plant boilers.

In the eighth and final study a retort plant is the medium utilized for the complete gasification of the coal. All the products, except tar and light oil, are burned under the power-plant boilers.

The studies are summarized in Table VII.

Conclusions

The following conclusions are derived from these studies:

1. With a combined coke-oven power generating plant it is possible to generate power with coke and breeze more cheaply than in a straight steam generating plant. However, the returns on the additional capital investment in the coke-oven plant are only 5 per cent to 10 per cent, an amount insufficient to justify the construction of such a combined plant.

2. With a combined complete gasification retort power generating plant it is possible to generate power more cheaply than in a straight steam generating plant, but not as cheaply as in a combination coke-oven power generating plant using pulverized coke and breeze as fuel.

3. That any combined gas-electric plant dependent upon the sale of coke as a byproduct is unprofitable due to the large increase in capital investment required, and also due to the difficulty of disposing of large quantities of coke at a price sufficiently high to cover conversion costs.

4. That there is not sufficient justification for building a combined gas-electric plant that is dependent upon the sale of gas as a byproduct, owing to the large increase in capital investment required.

5. That a combined gas-electric plant is profitable only if its cost is equal to, or but slightly exceeds, the cost of a straight steam generating plant.

6. The capital requirement for any combined gas-electric plant, where provision is made for the recovery of all byproducts from coal processing and their preparation for marketing, is so much greater than for a straight steam generating plant that the possibility of cheapening electric power generation by processing bituminous coal appears remote.

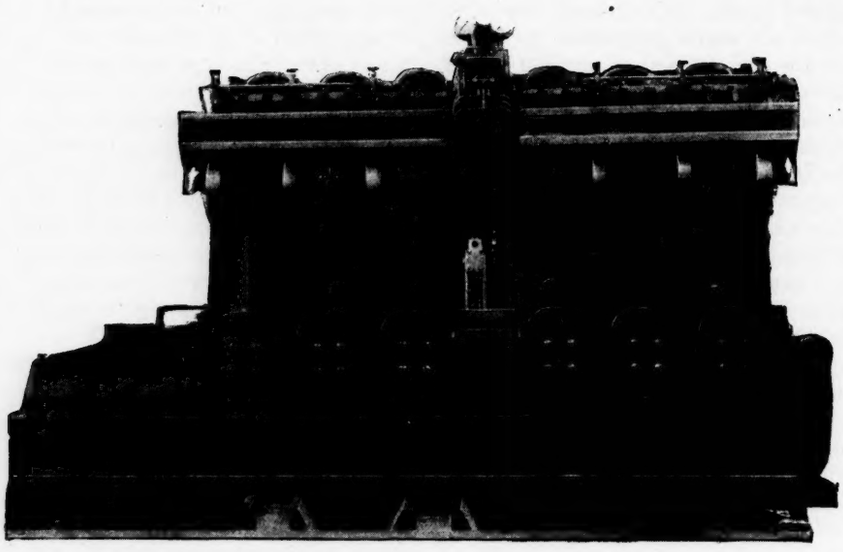
This article is based on an engineering report prepared for Stevens & Wood, Inc., New York City. Acknowledgement is hereby made of the courtesy of this company in making this information public.

Wet and Dry Bulb Temperatures

IT IS well for the engineer to understand that atmospheric air is a mixture of dry gases and water vapor. The temperature of the dry gases and water vapor is called the "dry-bulb temperature." The pressure of the vapor cannot exceed the saturation pressure corresponding to the dry-bulb temperature. Usually, the vapor pressure is less than the saturation pressure and the vapor is superheated. The barometric pressure is then the sum of the pressures of the vapor and of the dry air.

The density of the water vapor in the air is called its "absolute humidity." The ratio of the density of the water vapor in the air to the density of saturated vapor at the same temperature is called the "relative humidity." If the atmospheric air be cooled at constant pressure, the water vapor will become less superheated until at some temperature it becomes saturated. This temperature is called the "dew-point."

The practical method of determining the relative humidity is the evaporative method, in which the degree of humidity is deduced from the cooling effect of evaporating moisture into the air, which is only partly saturated. The wet-bulb psychrometer is used, the bulb of one of its thermometers being left bare, while the bulb of the other is covered with a cloth or wick saturated with water. The thermometers are then subjected to an air draft. Evaporation from the wet bulb causes a lowering of temperature. The difference of the two readings is called the "wet-bulb depression." The two readings enable one to find, from a psychromatic chart or formula, the relative humidity. An important point to note is that the wet-bulb temperature is not the dew-point, because the wet-bulb thermometer is heated by the surrounding air at the same time that the evaporation tends to cool it to the dew-point. An exception occurs, of course, when the relative humidity it 100 per cent. Then the dry-bulb temperature, wet-bulb temperature, and the dew-point are all identical.



DIESEL STARTING VALVES

Design and Operation

BY H. F. SHEPHERD
Diesel Engineer, C. & G. Cooper Company

THE solid-injection Diesel is in many ways a modern development, and it has been possible to incorporate in its design the latest and most approved starting devices, some of which are new to the operating engineer.

Most of the conventional semi-automatic valve designs in use on engines using pump injection and mechanically operated needle valves have one common property—the starting air admission valve in the cylinder head goes out of action automatically when the cylinder that it serves starts to fire. This obviates any danger of firing back into the air tanks. It permits starting with fuel on, which is always much more certain than the old method of rolling the engine on air, then throwing the hand gear that puts the starter out of action and the fuel valves in. The latter method is wasteful of air and altogether too slow for marine work. With the semi-automatic valve the main air throttle may be left open and the valve operating mechanism may be allowed to continue operation after the cylinders are firing. No harm will result, as the admission valve cannot open against the pressure of explosion.

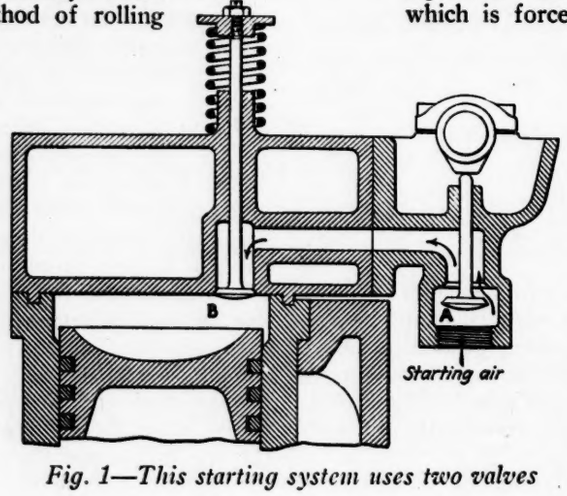


Fig. 1—This starting system uses two valves

The commonest of these devices and a very good one is that which originated with Burmeister & Wain. A balance piston opposes the automatic opening of the valve when air is admitted to the common air main to which all the starting valves are connected. As this balance piston is the same size as the inside of the valve seat, the valve is not quite balanced, because air tends to work in between the valve-seat faces and lift the valve. A spring makes up this difference and a little more to insure a tight valve. The spring also serves to hold the valve in place when the air pressure is shut off. A small hole is drilled up through the valve stem to the cushion cylinder on top of the stem. In this cylinder is a free piston which is forced up against the cap when air is admitted to the system. This operation extends the starting valve stem so that it comes in contact with the starting-valve operating lever at one end, depressing the other end into the path of the starting-valve cam. Thus, as soon as air is thrown on for the purpose of starting, all valves are thrown into the operating position. The engine begins to turn and air is admitted to the cylinders in sequence. As soon as firing begins, the explosion pressure holds the valve so firmly to its

seat that the air pressure within the cushion cylinder, being only one-third or one-fourth the explosion pressure, is not sufficient to force the valve open. The piston in the cushion cylinder then merely oscillates up and down without unseating the valve, until the operator shuts the air off.

Another commonly used system, Fig. 1, employs the valve in the cylinder head as a check, or non-return,

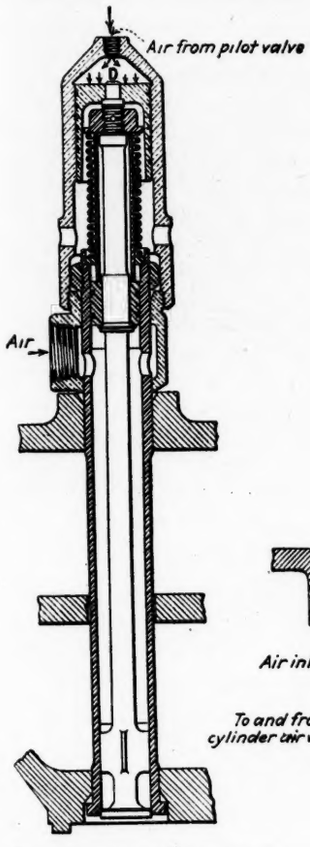


Fig. 2—A cylinder valve is operated from a pilot gear

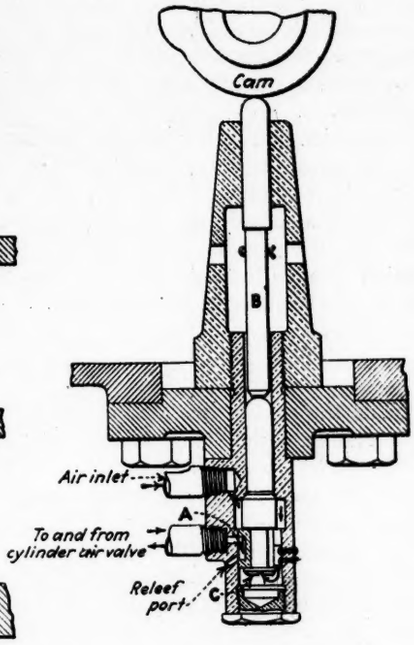


Fig. 3—A pilot gear using a little D slide valve

valve only. A second cam-operated valve *A* for each cylinder is located under the camshaft. When air is admitted to the air main by opening the throttle, the mechanically operated valve is raised by the unbalanced air pressure so that the stem comes in contact with the cam. The several valves admit air to the cylinders in sequence through the non-return valves *B* in the cylinder heads until the explosion pressure holds the latter shut and prevents further admission of air.

A System That Requires No Cam and Lever on Cylinder Head

Yet a third system is used, mostly because it requires no cam and lever on the cylinder head and because its cam-operated mechanism is quite compact and can be placed at any convenient position. In the system the valve in the cylinder head, Fig. 2, is balanced and spring-loaded exactly like the first one described. The valve is actually operated by an air piston, however, instead of being merely thrown into contact with its operating lever by the action of an air piston. In other words, the valve is pneumatically operated by admitting air to and exhausting air from an air ram mounted above the valve. The air is distributed to the valve-operating rams by pilot valves, Fig. 3, there being one of the latter for each cylinder. The pilot valve itself is a little *D* slide valve *A* with outside admission and exhausting through the space under the valve. A slide valve was chosen rather than a poppet valve because it combines both inlet and exhaust functions in one valve and because it is not easily unseated by grit or débris as is the poppet valve. The pilot valve is thrown into action by the admission of air to the system which moves the stem *B* upward and into the cam path by reason of the unbalanced area of the stem at *C*. It drops out automatically when air is shut off. The piston *D* that operates the cylinder admission valve, Fig. 2, is too small to open it against the pressure of explosion.

This system has the same properties as the other two discussed. It is common practice to use a reducing valve in the pilot-valve air main, set for some pressure approximating the lowest useful pressure in the air tanks, such as 150 lb. The air ram is then designed to function best at 150 lb. pressure, and the pilot valves and ram are not subject to the design disadvantage of having to work through a variable range of pressure, but work rather under a fixed condition, regardless of the tank pressure.

All these are what may be called "four-stroke-cycle" starting systems; that is, they admit air every other revolution. Older gears admitted air every revolution even when used on four-stroke-cycle engines. This was done by throwing the inlet valve out of gear and causing the exhaust valve to make an extra movement on what was normally the compression stroke. Air under pressure was admitted on what would normally be the power stroke, and on the intake stroke as well. This mechanism had the questionable advantage of permitting a start with a very low air pressure. It is now generally felt that higher pressure is essential to economy of space and tankage when much compressed-air energy is to be stored.

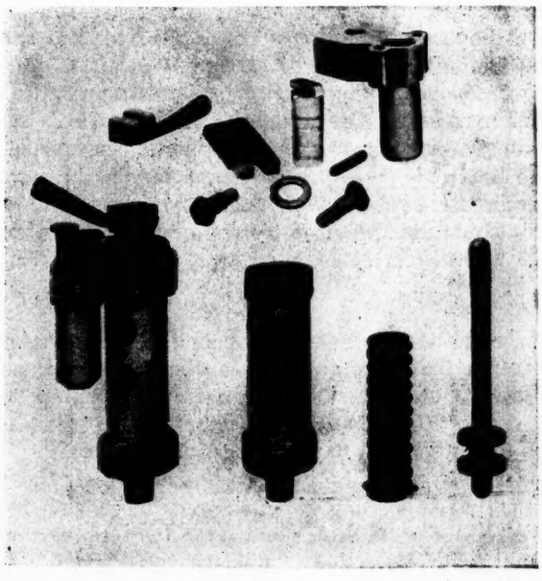


Fig. 4—Design of a relief valve with automatic unloading

Before being started engines with less than six cylinders are usually "set up" or barred by hand to a crank angle where one starting valve is in the cam-contact

position. Six-cylinder engines may admit air for 120 deg. of crank travel or more, with sufficient interval between the closing of the starting valve and the opening of the exhaust valve to avoid the direct loss of air from the tanks to the exhaust pipe, and will therefore pick up at any position. It is only necessary to open the air throttle to cause the engine to turn. Eight-cylinder engines in which the starting impulses overlap considerably, are very prompt in their getaway and are least likely of all to prove unreliable when wear alters the

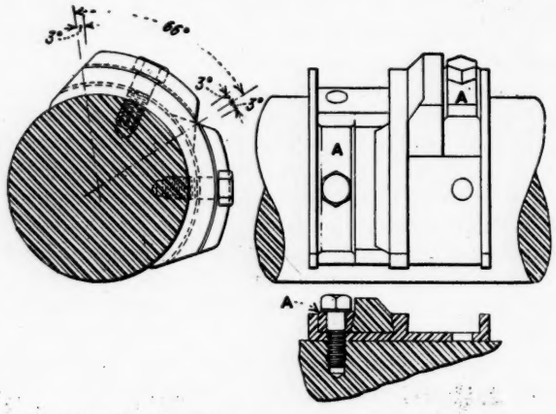


Fig. 5—Starting cams permit adjustment of timing

starter timing, as it usually does, by increasing clearances and shortening the angle of admission.

Starting systems for stationary engines are usually quite free from troubles. They are not often found on ships except those engaged in canal, river and harbor work, where they assume great importance. Instead of being used once a day or once in weeks or months this starter may be used several hundred times in 24 hours and must function perfectly each time if barge collisions are to be avoided. For this class of service the starting system must be built with just as much attention to detail as any other part of the engine and careful maintenance is absolutely essential.

How to Deal with Air Locking Troubles

Perhaps the most distressing and often mysterious occurrence the operator faces is air locking. Imagine two cylinders of a six-cylinder engine standing with their cranks at equal angles off center, one on the starter cam, the other on the compression stroke, but both cylinders charged with air at the pressure of the starting receiver. If this seems a remote and improbable condition, it is not so difficult to imagine two cranks ranged at some angle above that of exhaust-valve opening, with the cylinders charged with air at a pressure such that the turning effort of the one neutralizes that of the other. If there is pressure air in two cylinders and no momentum on the engine, the cranks will seek this position. It will then be impossible to move the engine by the use of starting air until the dead cylinder, the one not connected to the starter cam, is relieved of its pressure. There are so many possible and almost unavoidable causes for this condition that it is as well perhaps to pass over them and discuss only operative measures for dealing with the situation.

If the engine is a stationary one, it is only necessary to open the cylinder relief valves or vent valves one by one. Air will be relieved from two of them. The position of the starter cams should be noted. One of the two cylinders will show the cam in position to operate the pilot valve or the air-starting valve; the other cylinder is the air-locked one. If all vent valves are left open or an exhaust valve on the cylinder under starter be held slightly open by putting a shim between valve head and lever end to prevent starting, and air be admitted to the starter main by slightly opening the throttle, if that cylinder vent continues to blow the starter valve is leaky or stuck.

But the venting of cylinders by use of individual hand-operated relief valves is a process too slow for marine engines, although it does well enough for the stationary plant where minutes may not be so important as seconds on the water. Marine engines are fitted with two general types of mechanisms for dealing with this contingency. The first and best opens all exhaust valves each time the valve mechanism is thrown from the position for one direction of rotation to the opposite position.

A device that is coming into use for the same purpose is the air-operated cylinder relief valve. An American example is shown in Fig. 4. The little air cylinder *A* mounted alongside of the relief-valve spring case lifts the relief valve by lever action when air is admitted either manually through a three-way cock or automatically by interconnection with the air system used for reversing.

Starting Valve Timing

The timing of the starting valve should be given by the engine builder. Stationary engines with less than six cylinders, which have to be barred to starting position, may, for the sake of saving air, be given a comparatively short starting-valve cutoff. The valve may be open as little as 60 deg. and still give practically as good a starting impulse as with a longer admission. Again the period of admission may be 120 deg. or more in order that the setting may be standard for all engines of a certain manufacture, regardless of the number of cylinders and regardless of whether they are intended for stationary or marine service.

It is quite usual to give the starting valve a few degrees lead but seldom more than 10 deg. This should never be excessive for marine engines or other engines that are intended to start from any position without barring, although it is not dangerous on account of the more favorable position of the crank of the other cylinder that is receiving air at the same time as the cylinder with the valve on lead is receiving air.

In the case of the pneumatically operated starting valve, the setting of the pilot valve does not actually indicate the timing of the starting valve. There is a lag in both opening and closing due to the capacity of the piping between the pilot valve and the starter-valve air cylinder and the capacity of the air cylinder itself. This action must be developed by the maker by the use of the indicator applied to the air cylinder of the starting valve itself. The operator, of course, makes all his settings by adjustment of the pilot valve timing. This is done by disconnecting the small pipe connecting the pilot valve to the starter-valve cylinder. Air is turned on to the pilot-valve line and the engine is barred over until air starts to discharge from the little pipe. This indicates the opening of the pilot valve. The pipe is then reconnected and the engine barred further until the pilot valve exhaust begins to discharge through the little hole into the atmosphere. This indicates the

closing of the pilot valve. On account of the necessary lap of the slide valve the movements of the pilot valve stem, particularly the beginning of movement and the seating, do not necessarily indicate the actual starting-valve timing.

As has been indicated, the timing for six-cylinder direct-reversible marine engines must be set very closely. For this purpose a completely adjustable starting-valve cam such as is shown in Fig. 5, is used. By loosening the clamp segment *A* the nose of either cam may be moved any desired amount. The two cams are of course for ahead and astern motion. The duration of opening is usually fixed by grinding or filing that part of the starter or pilot valve which comes into contact with the cam. However, these adjustments are being much refined to suit the requirements of marine practice.

When engines have been operated for a long period without shutdown on land or sea, it is quite common for a deposit of burned oil to form about the starting-valve head and wing guide, sealing it against opening. Where effective starting is necessary to service or safety, the starting valves should be cared for by the exercise of a rigid routine.

On coming into a port each engine should be manœuvered to determine whether the starting valves are in working order. If not, it will be possible to make the necessary correction without the mischance of having the engine fail to respond in traffic or when docking. It is becoming more and more evident that all starting valves should not only be in cages, but also should be fitted with hand-operating gear, to permit freeing of the valve by hand working without the necessity of dismantling.

Aside from the operating precautions, starting valves in service where their working is imperative, as in tugboats and the like, are cleaned sometimes daily and certainly once a week. While these precautions seem to apply to marine service only, they are equally important in power stations where good condition of the starting system is essential to the readiness of the engine to meet a demand for a reserve engine to come in on the peak load or to substitute for a unit that must be shut down. They are important in the isolated manufacturing plant where failure to start in the morning may result in a payroll hour with no production.

How to Sample Coal From Unit Pulverizers

By R. S. JULSRUD

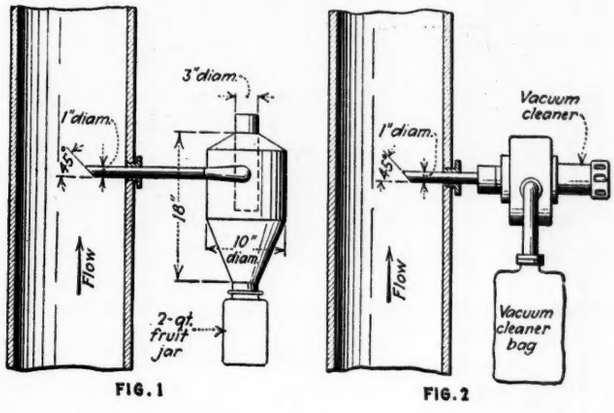
Chief Engineer, Fuel Efficiency Engineering Corporation

THE rapid growth of the unit system of pulverized-coal firing, and the increasing attention being paid to the effect of fineness of the product upon boiler efficiency and maintenance have caused operators and manufacturers of this equipment to look for methods of obtaining representative samples from the fuel-delivery pipes of unit mills.

To this end many methods have been proposed, but as yet none has proved entirely satisfactory in obtaining a true representative sample. To obtain such a sample a complete exploration of a cross-section of the delivery pipe would be necessary. In addition the time interval of sampling at each point would have to vary as the density and velocity of the mixture in the pipe at that point vary, and, further, the velocity through the sampling tube also varies during the sampling period owing to increased resistance caused by the coal dust adhering to the sides of the collecting bag filter in the collecting bag or cyclone collector. Thus the difficulty of obtaining a true average sample is apparent. However, some knowledge of the performance of unit mills, even though not exact, is necessary in order to improve their operation.

I have tried several methods of sampling pulverized coal and have obtained a wide variation of results from them.

Figs. 1 and 2 show the first attempt to obtain an average coal sample. In Fig. 1 the sample was taken from the pressure side of the fan and collected by a small cyclone separator into a two-quart fruit jar. Samples also were taken from the suction side of the fan by using a vacuum cleaner, as shown in Fig. 2.



Figs. 1 and 2—First methods of sampling tried

The fuel fired was Texas lignite containing 35 per cent moisture. The samples were taken across one diameter, the tube being moved uniformly back and forth across the pipe for a period of ten minutes. During this time rate of feed, the kind and moisture content of the coal and mill conditions were held constant.

The wide variation in the screen analyses of the samples obtained by these methods is apparent in Table I.

It is believed that neither of these analyses indicates even approximitely the actual fineness obtained in this mill, test No. 1 being too coarse and test No. 2 too fine.

TABLE I—SCREEN ANALYSIS OF SAMPLES TAKEN AS IN FIGS. 1 AND 2

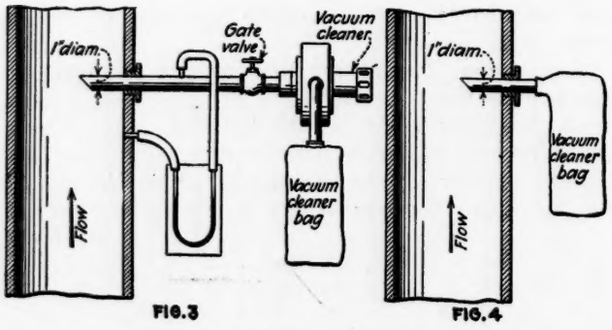
Test No.	1	2
Place of taking sample	Pressure side of fan	Suction side of fan
Method of taking sample	Fig. 1	Fig. 2
Pressure in sampling tube	Same as in fuel pipe	6 in. suction
Screen analysis:		
Per cent through 20 mesh	98.5	100.0
Per cent through 40 mesh	89.4	99.8
Per cent through 60 mesh	76.5	98.2
Per cent through 100 mesh	63.8	91.8
Per cent through 200 mesh	44.2	70.8

In order to study the effect of the pressure or suction maintained in the sampling tube, the sampling equipment was altered as shown in Figs. 3 and 4. Here again a wide variation in screen analyses was obtained as indicated in Table II. In Fig. 3 the suction of the vacuum-cleaner motor was regulated by a gate valve to obtain any desired suction in the sampling tube.

The samples in the first test were obtained by opening the gate valve wide, creating a suction of 5 in. in the sampling tube. In the second test this suction was

reduced to 0.2 in. of water by partly closing the valve. In the third test the vacuum cleaner motor was removed and the sample blown directly into the bag. The different analyses clearly indicate the effect.

In each test the feed, coal and moisture remained practically constant. Samples were taken across two diameters at right angles to each other the tube being moved uniformly across the duct for periods of ten minutes on each traverse, and the total sample was used for analysis.



Figs. 3 and 4—Sampling methods used to determine effect of suction or pressure maintained in the sampling tube

In addition to the variations shown in Table II, there was found a wide divergence in the analyses of samples taken across each diameter as shown in the following screen analysis for the sample obtained in test No. 3.

	North and South Traverse	East and West Traverse
Held on 48 mesh	7.4	1.8
Held on 100 mesh	8.2	4.4
Held on 200 mesh	15.6	12.5
Passed 200 mesh	64.1	80.0

The results obtained from the fourth test seem to represent more closely the actual pulverization being obtained, and the method of sampling appears more reliable than either of the previous methods. It has, however, an objectionable feature. The high suction from the vacuum-cleaner fan necessitates nearly shutting off the gate valve to maintain a balance or slight suction in the sampling tube. This in turn tends to build up the mixture ahead of the valve and the coal dust eventually obstructs the valve opening, especially if the

TABLE II—SCREEN ANALYSIS OF SAMPLES TAKEN AS IN FIGS. 3 AND 4

Test No.	3	4	5
Place of taking sample	12 in. above discharge flange on fan		
Method of taking sample	Fig. 3	Fig. 3	Fig. 4
Pressure in sampling tube	0.5 in. suction	0.2 in. suction	0.5 in. suction
Screen analysis:			
Per cent on 48 mesh	4.6	5.7	12.9
Per cent on 100 mesh	6.3	9.2	14.1
Per cent on 200 mesh	19.0	19.5	20.4
Per cent on 300 mesh	72.0	60.4	44.6

fuel contains much moisture. Furthermore, the variation in the screen analyses of the North and South and the East and West traverses would seem to indicate that the method of moving the sampling tube in and out could not be made to yield consistent results.

The trouble caused by the valve in Fig. 3 was overcome by placing it between a cyclone separator and the vacuum-cleaner fan as shown in Fig. 5. In this position the valve does not place any restriction in the sampling tube, and the separator can be tapped during the sampling to clear the filter of dust, thus preventing it from building up pressure in the system during the sampling period. The results obtained with this method are as given in Table III.

In test No. 6 the sample was taken from the exhauster discharge 12 in. above the fan flange. Instead of moving the sampling tube in and out, five points were taken over equal concentric areas and two traverses at right angles were made. The tube was held at each point for equal time intervals. A 10-in. diameter cyclone separator, as shown in Fig. 2, was used to collect the samples.

In tests Nos. 7, 8 and 9, an 18-in. diameter separator, as shown in Fig. 5, was used. Samples were taken from the suction side of the exhauster side where the pipe

TABLE III—SCREEN ANALYSIS OF SAMPLES TAKEN AS IN FIG. 5

Test No.	6	7	8	9
Place of sampling	Pressure side of fan	Suction side of fan		
Method of taking sample	Fig. 1	Fig. 5	Fig. 5	Fig. 5
Suction in sampling tube	6 in. pressure	0.05 in.	0.10 in.	0.20 in.
Screen analysis:				
Held on 50 mesh	6.3	4.0	3.7	3.9
Held on 100 mesh	22.0	12.6	11.5	11.4
Held on 200 mesh	29.4	19.6	20.7	21.9
Passed 200 mesh	42.0	63.8	64.1	62.8

was straight for five diameters preceding the sampling tube. Traverses were made across two diameters at right angles. Ten points covering equal concentric areas were used on each traverse and equal time intervals at each point were taken.

All the results illustrate the wide divergence in screen analyses resulting from the various methods of sampling, and of the different methods discussed that shown by Fig. 5 is, in my opinion, the most accurate. It is true that for more accurate results, the pressure tube in the fuel pipe should be near the opening of the sampling tube and move with it over the traverse, but it is not believed that the added complication warrants this.

The results indicate the necessity of adopting some standard type of sampling apparatus and procedure, if

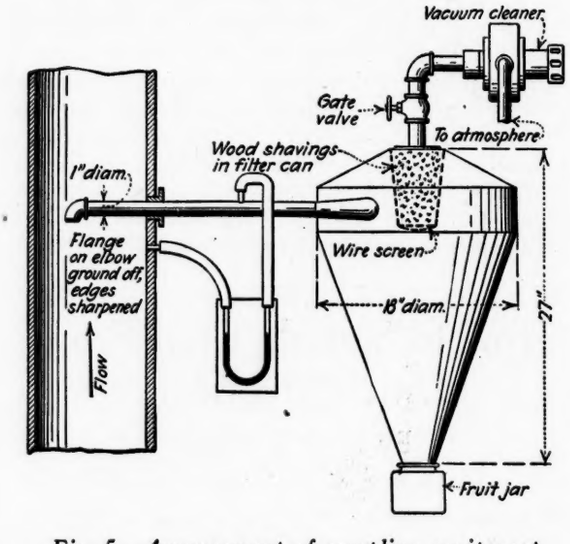


Fig. 5—Arrangement of sampling equipment found to give best results

results obtained are to be used for comparing the performance of different machines and different mill conditions. Because of the great variation in the screen analyses of the various samples it is hoped that others will undertake experiments along this line and that the results of their work will be reported.

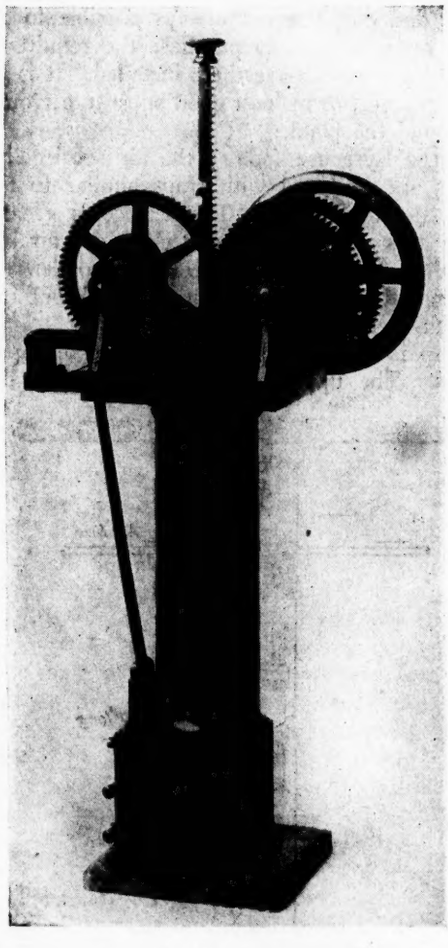
It has been jokingly said, "Tell me the fineness you want and you shall have it." My experience can certainly verify this statement.

Otto Atmospheric Gas Engine Wanted by the U. S. National Museum

JUST fifty years ago the Paris Exposition of 1878 made known the practicability and remarkable efficiency of the Otto "Silent" gas engine. This forebearer of the millions of horsepower of internal-combustion engines doing universal service today is represented in the National Museum at Washington by one of the type first built in the United States in 1878.

Before this date, however, N. A. Otto with Eugen Langen had developed at Cologne (1866) a free-piston, slide-valve gas engine, an example of which the Museum is anxious to obtain.

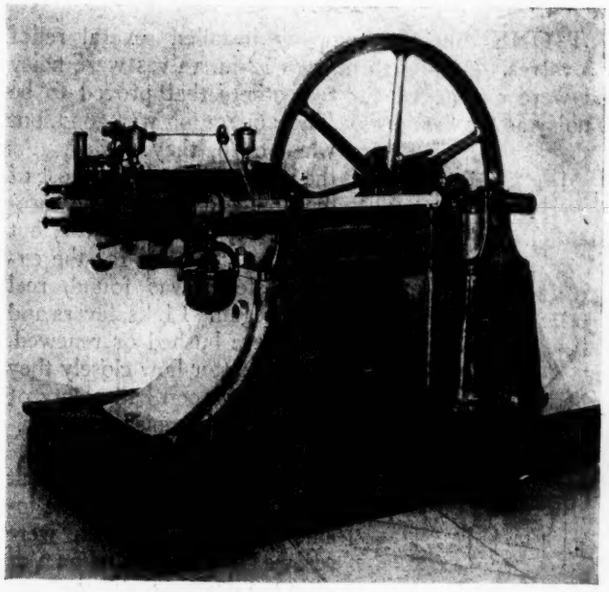
This engine was built vertically with the crankshaft above the cylinder. The explosion of gas forced the piston upward to the top of its stroke, where it engaged a rack which turned the crankshaft on the down stroke of the piston. The weight of the piston, assisted by the vacuum formed by the cooling gases, caused it to descend. The inertia of the flywheel started the piston on the upward stroke and the vacuum formed drew in a charge of gas. This charge was exploded when the piston was partly advanced on the upstroke.



Vertical Otto & Langen free-piston engine of 1867, one of which is desired by the National Museum.

Besides being very inefficient as compared with the later engine, this early one was extremely noisy. For these reasons it was not popular with either the operating engineer or the people who had to live within a mile or two of it, and its application was not wide. However, it is reported that within the nine years that it was made, several were brought to America and used. In the hope that there may be one of these engines still in existence, the National Museum is making an effort to locate one that might be obtained for the collections at Washington.

The Patent Office model of this engine of 1867 is a good miniature of the engine as it was built. The Museum exhibits this model now, and a photograph of it is given here to refresh the memories of those engineers who may have seen one of these engines in operation or retired to an out-of-the-way corner of some shop of their acquaintance. Information or suggestions as to the locating of such an engine will be appreciatively received by the U. S. National Museum, Washington, D. C.



Otto four-stroke-cycle engine of type first built in the United States (1878), one of which is now in the National Museum

Steam Preserves Valuable Manuscripts

TO PRESERVE priceless manuscripts in the library of the Vatican at Rome, an electric steam generator has been built, which, by emitting steam into the library, will keep the ancient books and valuable manuscripts from cracking as a result of the excessively dry air experienced there during the winter months. The steam will enter through a valve operated by a humidistat, thus making the installation completely automatic in operation.

But the summer climate in Rome is excessively humid and to prevent the manuscripts from decay there also has been installed an electric heating apparatus. Both the humidifying and the heating equipment were made by the General Electric Company.

Among the new buildings in New York City, one that is attracting unusual attention is the

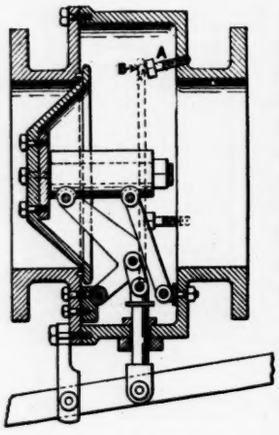
New York Central Building

The heating and ventilation will be described next week and the electrical services at an early date.

Right Out of the Plant

Stopping Noise of Atmospheric Relief Valves

AT ONE time the company installed several relief valves. Among them, two 12-in. valves were noisy and were exchanged for two others that proved to be as noisy as the first ones. Their operation was good, but when open, they rattled. As the valves were closed most of the time and were in the basement, they bothered little, but later, as other use for the exhaust steam was found, real noise began. Links, levers and pins were bushed or renewed, but no matter how closely they fitted, they soon had plenty of room and the noise was deafening.



Section of relief valve showing the location of the bolts

The valves were taken out and into each body, on the inside back of the disk, were screwed three bolts, shown at *A* in the drawing. These bolts were spaced 120 deg. apart and the length and location were such that the disk opened to about the center of the space, with the back edge *B* of the disk, when open, resting against the bolts. The noise was entirely stopped.

Elgin, Ill. W. L. PARKER.

Why the Architect Should Not Design the Power Plant

THE opinions of Frank L. Gillmor regarding architects' attempts at boiler or power-plant design, as expressed in his article in the March 26 number, are well taken. Granting that an architect is necessary for structual and artistic reasons and that as a rule they do a good job in the design of the building proper, there are few who can be trusted with the design or layout of even the simplest power plant or electrical installation.

Many of them boast of a mechanical engineer who is only too often a draftsman who has not done well in the architectural end and has been shifted to the mechanical end because it is considered of little consequence. Seldom do these have any practical experience or even theoretical training in this line, and it is only natural that the result of their work depends largely upon the ability, experience, integrity and degree of confidence inspired by the salesman of equipment.

I do not believe it would be an exaggeration to say that four out of five times an experienced engineer can tell by a glance at a plant whether it was laid out by an engineer or by an architect.

Not only are state codes and local ordinances disregarded, but the most elementary principles of engineering and safety are violated. Boilers, pumps, motors and other equipment are fitted into any available space left after everything else is taken care of.

Perhaps it is asking too much to expect owners to retain consulting engineers to pass on the practicability of architectural power plants which, after all, are a small part of the entire building. It does seem, however, that the engineer who is to operate the plant could be used to advantage to check over some of the details of design at the time of construction and at least protect the owners against costly changes that must be made later.

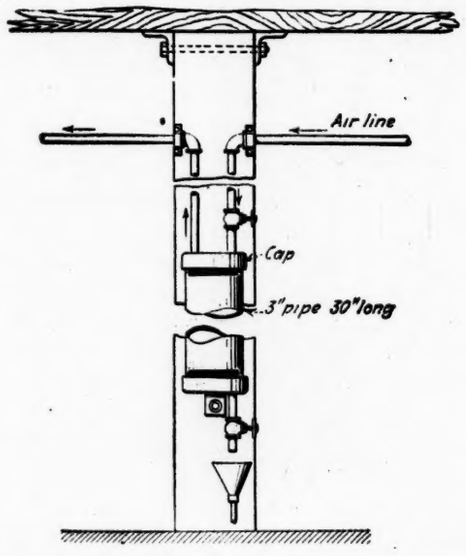
St. Petersburg, Fla. PAUL F. ROGERS.

Improvised Oil and Water Trap for Air Lines

ALTHOUGH most engineers consider it good practice to have separators on air service lines to remove the water and oil, it is not always possible to get the necessary appropriation to purchase the required number of separators and have them installed. It is usually possible, however, to make a good substitute from scrap found around the plant.

In a large Syracuse factory the air service lines on each floor are equipped with traps similar to the one shown in the illustration. The service is greatly improved by this simple device and clean dry air is available at all times. Once a week the condensation is drawn from the cylinder, which has sufficient capacity for a week or more.

The trap is simply a piece of 3-in. pipe capped on both ends. The upper cap is tapped for intake and outlet connections, while the bottom cap is tapped for the drain. Valves are fitted top and bottom. This device should be fitted to the air line near some support such as a pillar or post or at some convenient point along the wall of the building. The location is not so important as long as the air passes through the trap before it reaches the service outlets.



Trap located on building post and connected in air line

H. L. WHEELER.

Syracuse, N. Y.

The Steam-Flow Air-Flow Meter

THE question of eliminating the CO_2 indicator when using a steam-flow air-flow meter seems to be a live subject at present.

The Orsat CO_2 instrument is used in boiler rooms where boiler meters are installed, but only as a check on the meters. Primarily, it is not CO_2 which the boiler attendant is interested in, but the amount of excess air present in the furnace, because high CO_2 may not be a sign of good combustion for there may be CO present. If the proper amount of excess air is present, CO is present in such small amount that it may be disregarded. A low CO_2 always means low efficiency, but a high CO_2 does not always mean good efficiency; thus we need something besides a CO_2 meter to give us the complete story of conditions inside the furnace.

Air may be considered a fuel just as coal, oil or any other combustible. E. G. Bailey has shown that the amount of air necessary to liberate 10,000 B.t.u. is practically a constant no matter what the B.t.u. content of the coal burned happens to be. The heat liberated by the combustion of the fuel in the furnace is measured by the steam output or rating of the boiler.

Knowing these two factors, it may be readily seen that the air flow can be adjusted so that when the proper amount of excess air is present for efficient combustion, the air-flow and steam-flow pens will be together. Should there be too much excess air, the air flow will read higher than the steam flow, and with insufficient air the air flow will read lower than the steam flow.

This gives the boiler attendant the complete story of what is happening in the furnace at a glance, and if conditions are wrong he knows at once what steps should be taken to correct them. The Orsat is used in setting the air-flow adjustment of the boiler meter and may be used from time to time to check this setting, but other than this the boiler meter gives us the necessary information and so does away with the need of a CO_2 meter.

Springfield, Ohio. W. W. BABCOCK.

THE meter recording air flow to the furnace and the steam flow from the boiler eliminates the necessity of the CO_2 recording instrument as a guide for boiler operation, but does not remove the necessity of the Orsat as an important boiler-room adjunct.

The air-flow steam-flow meter has been found reliable and efficient as a guide for boiler operation. It shows the operator and the engineer just how much air is being used for combustion, which is the only purpose of the CO_2 recorder. It is more reliable and requires much less attention and maintenance than most types of CO_2 recorders.

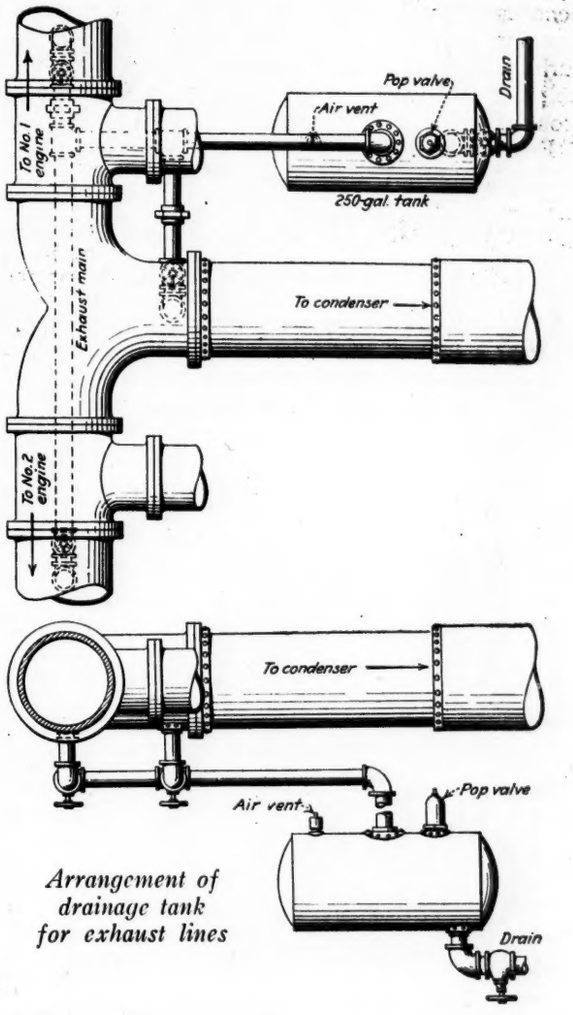
Its accuracy may be affected slightly by ash or soot on the tubes, leaky settings or broken baffles, but any of these conditions will be indicated by a rise in flue-gas temperature, and should be corrected at once. The air-flow steam-flow meter with flue-gas temperature recorder attached gives as clear and complete a story of boiler operation as any combination of recorders.

The Orsat apparatus is very necessary, however, in order to get more detailed information on combustion conditions or for making changes in the air-flow setting on the meter. We may make a change in the grade of fuel used or in the type of furnace lining or refractory, and so find it necessary or advantageous to change the amount of excess air used. Another use for the Orsat is in detecting faulty distribution of air to a wide furnace or to different burners with pulverized fuel, gas or oil. In using the Orsat, every flue-gas sample should be analyzed carefully for CO_2, O_2 and CO in order to determine the minimum excess air without loss due to incomplete combustion. W. D. MACKINNON.

Donnacona, Quebec, Can.

Flooding a Barometric Condenser

THE recent articles concerning the methods used to drain the condensate from the exhaust line between a power unit and the barometric condenser, have interested me. The accompanying sketch shows the arrangement of the system in use at our plant. Two condensers are operated, one at each end of the power house,



Arrangement of drainage tank for exhaust lines

serving two turbine-generators and two turbine-blowers. Both condensers are served by the same circulating water pump. This arrangement gives good service so long as the vacua are maintained at or near the same point.

Should the vacuum be "lost" on one unit, the other will monopolize the water and flood the exhaust line. If an alarm is fitted in the tank, it will give warning of this condition and the operator can check it by closing the circulating water valve a little. The advantage of the tank system over a trap in an installation of this kind is easy to see. Should the condenser and exhaust line begin to flood and fill the tank, causing the alarm

to be sounded, there will be less water in the exhaust line, and the operator will have more time in which to correct the trouble before any damage is done. The tank system has worked successfully here for five years and never has given a minute's trouble or been the cause of an interruption in the service.

The first cost of the tank system may be higher, but its operating cost over a long period of time is practically nil, whereas the trap will have a fixed operating cost and may fail to function when sorely needed. Simplicity of design and ease of operation is the keynote to long life and efficient service. The tank has no floats nor other automatic controls to get out of order and should last as long as the plant.

Under normal conditions the rate at which the tank fills serves as a guide or visible check on the operation of certain auxiliary equipment. Any unusual amount of condensate may indicate wet steam, header traps not working properly, atmospheric relief valve leaking, or turbine-shaft water seals leaking, so that attention may be given to any one or all of these possible sources of trouble.

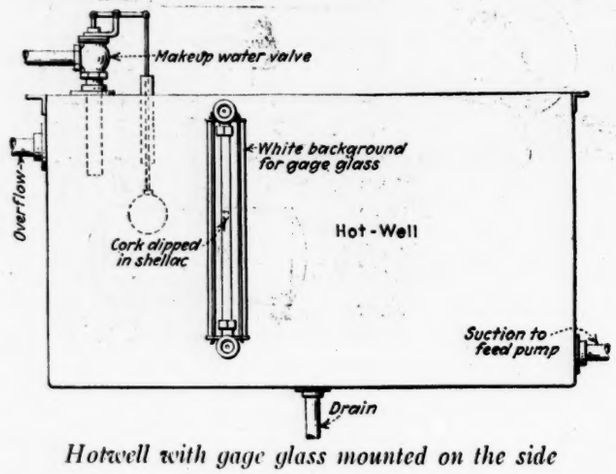
W. C. JONES.

Provo, Utah.

Gage Glass on Hotwell Saves Condensate and Reduces Scale

ALTHOUGH the advantages of having a gage glass on a hotwell might be well known to many engineers, there are undoubtedly some young ones in the field who could benefit by knowing some of these advantages.

Until recently, our hotwell was operated in the usual way, at times an excess of makeup water flowing to it and at other times a considerable overflow to the sewer. Since the installation of a gage glass, with a cork inserted in it, the height of water in the well is readily observed at all times and shows any wide fluctuations in



Hotwell with gage glass mounted on the side

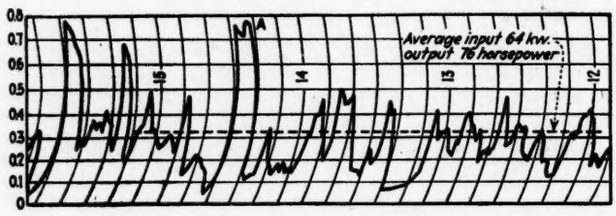
the condensate returned from the heating system of the building. It also shows if the float valve is working properly. The general arrangement of the hotwell and connections is shown in the illustration. The cork was dipped in black shellac before inserting it in the gage glass and a white background is provided at the back of the glass, so that the water level, as indicated by the position of the cork is readily observed, even from a considerable distance.

J. H. BECKMAN.

Oakland, Calif.

Flywheels Not a Cure-all for Peak Loads

FLYWHEELS have many applications to assist in carrying peak loads on motors and other power equipment, but the kind of peak loads to which flywheels are adapted is frequently overlooked. This seems to be what S. E. Nichols has done in his short article "Flywheel Might Have Carried the Peak Loads," on page 479, March 19 number. He discusses the article on "Graphic Instruments," on page 306, February 19 number and expresses the opinion that a flywheel might have been used to carry the peak loads indicated by Fig. 1 in the graphic instrument story. This figure is reproduced herewith.



Load on 75-hp. motor driving chipper

This graph shows that the maximum load on the motor reached 148 kw., which was 230 per cent of the motor's rating. The trouble was overcome by installing a 150-hp. machine.

A study of the figure will indicate that the peak loads are of entirely too long duration for a flywheel to be of any use. Take peak *A*, which is of seven or eight minutes duration. Such a peak load cannot be taken care of by any reasonable flywheel. Furthermore, if the flywheel is to absorb this peak, the motor must slow down during the period it exists to allow the flywheel to supply the overload. Either one of these conditions makes the use of a flywheel impractical.

When a motor subjected to overloads that run into minutes, about the only way of handling them is by sufficient motor capacity. There might be some question why a 125-hp. motor was not used instead of the 150-hp., but this cannot be decided without a longer record of the load than shown in the figure.

For peak loads of short duration, such as occur on punch presses and similar devices, a flywheel can be used to good advantage to relieve the motor. In such applications the peak load lasts for only a few seconds at most and in many cases for only a fraction of a second. If a flywheel is to be effective, the motor must have a drooping-speed characteristic. A synchronous motor would not be suitable for such applications, as this type of motor has a constant speed, fixed by the frequency of the power circuit.

On compressor applications flywheels are used with synchronous motors to help absorb the load pulsations during each revolution. In these applications the load pulsations last for only a part of each revolution of the crankshaft, and the flywheel is made effective by a change in the phase angle between the rotor and the stator of the motor. If the frequency is constant the motor will run at a constant number of revolutions per unit of time, but its speed is not constant during each revolution.

I agree with Mr. Nichols that care should be used to have all motors as nearly loaded as possible, but we want to be careful how flywheels are applied or the trouble will be aggravated instead of alleviated.

Cleveland, Ohio. M. E. WAGNER.

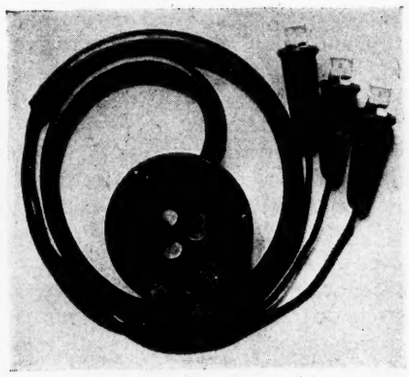
What's New in Plant Equipment

HOW THE MANUFACTURER CONTRIBUTES TO THE JOB OF GENERATING TRANSMITTING AND APPLYING THE POWER SERVICES

Phase Sequence Indicator

A DEVICE, shown in the figure, known as the Knopp phase sequence indicator, has been placed on the market by Electrical Facilities, Inc., 3712 San Pablo Ave., Oakland, Calif.

On polyphase systems a reverse phase results in the reversal of



Indicator checks phase rotation of polyphase circuits

motors, which may cause serious damage to the driven equipment. Not infrequently reverse phase is the result of a line change or to disconnecting a line for repairs and connecting it back into the system again. This sequence indicator is designed to provide a device that can be conveniently taken on the job by workmen to check the phase sequence rotation and prevent trouble due to a reverse phase.

The indicator is compact, being only 3¼ in. in diameter by 1 in. thick. It is easy to apply and can be suspended from the circuit by its three leads, which are 3 ft. long. If a motor feeder is to be disconnected, the indicator is connected to the line, on the motor side of the proposed opening, so as to obtain the correct direction of rotation of the indicator. The line is then disconnected, and when the changes have been made the line is again connected to obtain the original rotation on the indicator. The instrument has a voltage range of 50 to 500 volts and is provided with a push button to connect and disconnect the indicator from the line being tested.

Instrument for Indicating and Recording the Density of Smoke, Liquids or Dust

TO PROVIDE a more practical means of determining the density or quality of the smoke going up the stack than the usual method of visual observation (which can be made only in the daytime) and comparison with a Ringelmann or other chart, Frank Sawford, 610 Credit Foncier Building, Vancouver, B. C., Canada, has brought out the smoke density meter

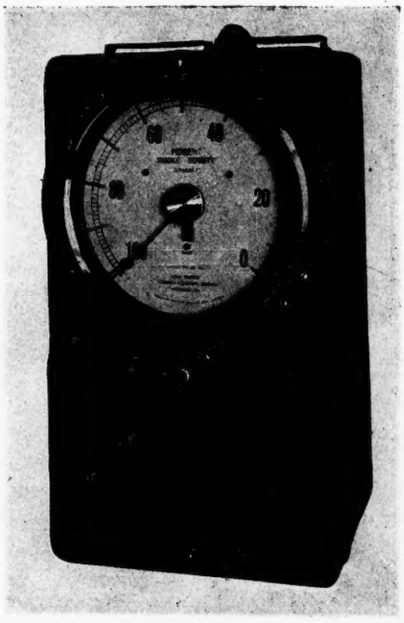


Fig. 1—Smoke density meter; cover in lower part of case incloses control unit

illustrated. It can be used alone to indicate the combustion condition within the furnace or to supplement a CO_2 meter and thereby simplify the adjustment of the furnace conditions to maintain the highest possible CO_2 with a minimum of smoke or the highest efficiency of combustion for any given furnace condition.

The instrument is based on the principle of the measurement of density or opacity of any medium to transmitted light, and the readings are interpreted in terms of percentage density, 100 per cent density being total opacity to light and 0 per cent density being clear or offering no reduction in the intensity of light.

The meter consists of two principal parts, an optical system, which is an apparatus for transmitting a beam of light through a portion of the smoke or gas to be measured, and a light sensitive device to receive the beam of light after transmission; and a meter for indicating or recording the density, together with the current supply and control equipment.

The general arrangement of the meter may be seen in Fig. 3, which shows in diagrammatic form the general arrangement of the complete equipment, including the type A optical system, type EW recorder, and type AC indicator.

The optical system, of which there are two forms, types A and B, is mounted on a length of standard 3-in.

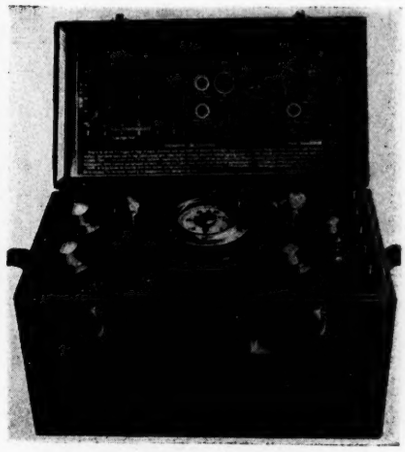


Fig. 2—Portable meter with cover open

pipe. In the case of type A system shown in Fig. 3, the pipe is passed through openings cut through opposite sides of the flue or stack, on the ends of which pipe are mounted the photo-electric cell and light projector. Through opposite walls of the pipe are cut the orifices, which allow a definite portion of the smoke to pass across the light beam.

The type B optical system is used where it is difficult to pass the orifice

pipe through the gas stream. This system also uses standard 3-in. pipe, but the pipe is used to bypass a portion of the flue gas from the flue through the optical system and return it to the flue.

Both types of systems are identical with the exception of the pipe, and consist of a lamp fitted with a silvered parabolic reflector arranged to give a parallel beam of light across the smoke orifice onto a lens which concentrates the light onto the sensitive surface of the photo-electric cell, which is covered with a protecting housing to shield it from light other than that from the lamp. Optical systems with special orifices are also supplied for the measurement of smoke in traffic tunnels, density of paper-pulp solutions, density of liquids, or any other medium through which light can be transmitted.

The indicating meter, Fig. 1, has incorporated in the lower part of the case, the current-control equipment for furnishing a proper supply of current to the projector lamp and amplifier. The total current consumption of the standard model, which is designed for operation on 110 volts single-phase 60 cycles, is about 60 watts. For operation on other frequencies and direct current the same instrument is used with a suitable motor-generator or rotary converter.

The indicating instrument is a milliampere meter with a dial 8 in. in diameter, the scale of which is an arc of about 300 deg., giving an actual scale length of about 16½ in. This deflection is obtained entirely without gearing. It will be noted that the scale readings are reversed according to usual practice; that is, zero on the scale is at the right hand, reading around the scale to 100 per cent dense at the left.

The point of zero density, however, is actually the full-load reading of the meter as a milliammeter. The interval between 100 per cent dense and the position marked off is provided for the purpose of checking the accuracy of the instrument and to prevent false readings by manipulation of the controls.

The control unit consists of suitable apparatus for furnishing the correct potentials for the projector lamp and the filament of the amplifying tube, and also the correct direct-current potentials for the grid and plate of the amplifying tube.

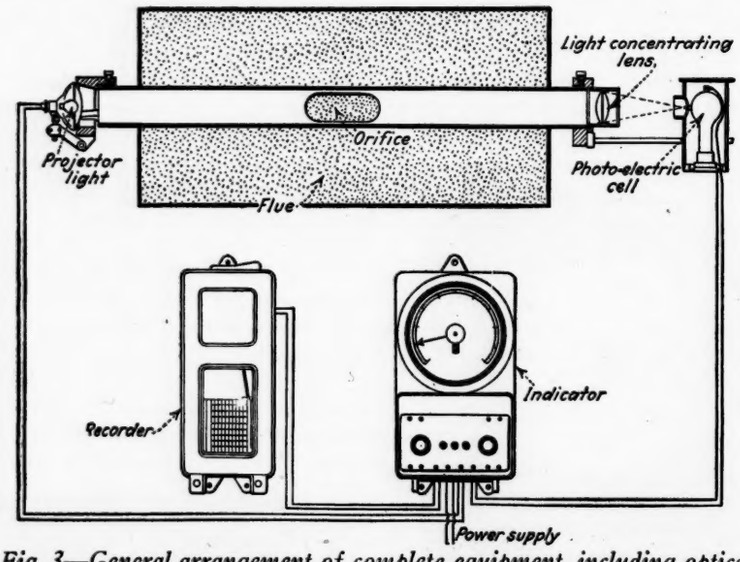


Fig. 3—General arrangement of complete equipment, including optical system, indicator and recorder

In the operation of the meter the photo-electric cell functions as a variable resistance, whose resistance to current flow is governed by the intensity of light shining on the sensitive surface. When dark, the cell is a non-conductor and the current flow through the amplifying tube is at a minimum, due to the high negative potential impressed on the grid.

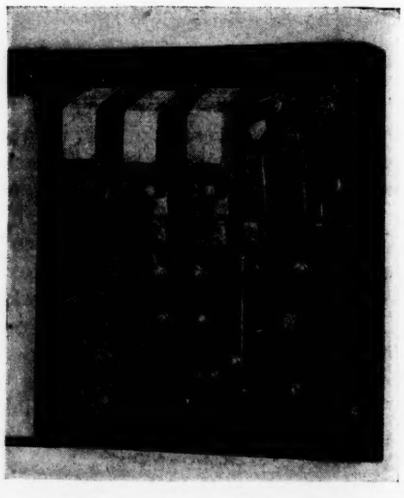
The recorder is of the strip chart type. The graduated portion of the chart is 3½ in. wide and has straight time lines, which render it particularly easy to read.

A portable meter, shown in Fig. 2, can also be furnished for use by engineers in making boiler tests. The current supply and control equipment is similar to that used for the stationary model, with a 3-in. diameter indicating meter fitted within the case. Terminals are provided for convenient connection to the photo-electric cell, projector light and, if desired, the recorder. The portable instrument is mounted in a case 14½x7½x9½ in. and is fitted with a convenient carrying strap. The weight of the instrument is approximately 15 lb. A portable recorder is also available.

"Deion" Principle Applied to Linestarters

INCREASED safety, economy and rating through the use of "Deion" contactors are claimed for the class 11-200 linestarters put out recently by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa.

The "Deion" contactor is designed to confine and smother the arc quickly without the usual flash and attendant scattering of flame. Not only does it provide for a greater degree of safety to the operator, but it also permits a smaller enclosure and the consequent decrease in the over-all size of the starter. The contacts are guaranteed to rupture from twelve to sixteen times their normal current-carrying capacity at rated voltage under severe operating conditions of low power factor and sustained voltage.



Linestarter with door open

During operation the following sequence takes place: (1) The arc resulting from opening the circuit is drawn in air; (2) blown into the deionizing chamber by a magnetic field; (3) the original arc is broken up into many short arcs; (4) each short arc is magnetically rotated to extinction; (5) complete deionization occurs, as the line current passes through zero, and the circuit is broken.

Floor Grating Mechanically Locked

WITH boilers and generating units increasing in size and better lighting of the power plant a primary factor in the design, there has been a trend toward the more extensive use of floor grating, walkway galleries and stairways connecting the different levels. In the construction of this grating, certain new ideas have been developed by the Walter Bates Steel Corporation, Gary, Ind., that insure rigidity by the use of mechanically locked joints.

In the process of making the grating indicated in Fig. 1, the crossbars

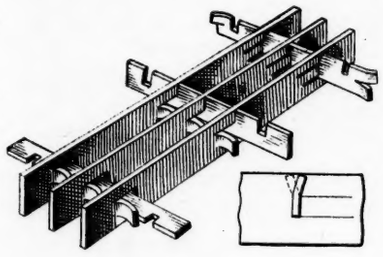


Fig. 1—Method of constructing the steel floor grating

are slotted halfway down from their top edge so as to permit them to straddle the upper portions of the main bars after they have been turned up into their permanent position. Slots at the centers of the main bars are provided to receive the crossbars, with the tongue of metal from the slot pushed aside as indicated in the illustration. In the slots in the foreground the crossbar has been inserted; at the next joint it has been turned up into its permanent posi-

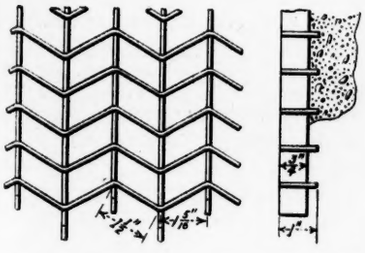


Fig. 2—Zigzag arrangement of "Florarmage"

tion, and at the third joint the tongues of metal have been pushed back to fill the slots. Then to make the crossbars act as bracing elements, their upper halves in the spaces between the main bars are bent alternately, first in one direction and in the adjacent space in the opposite direction. Alternating the direction of bending the crossbars throughout the construction creates a truss effect that materially increases the rigidity of the floor.

To meet the demand for suitable areas of trucking surface, a "Florarmage" has been developed. It is made by turning the grating upside down, leaving out every other main bar and shifting the grating, as indicated in Fig. 2, to create a zigzag effect. As the crossbars are below the surface, there is a continuous run of concrete between the main bars. This construction is intended to eliminate the breaking of small blocks of concrete from a floor, such as might be occasioned by a shock load or by the dropping of a heavy article on a small section.

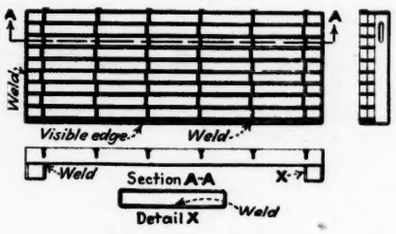


Fig. 3—Construction of stair tread

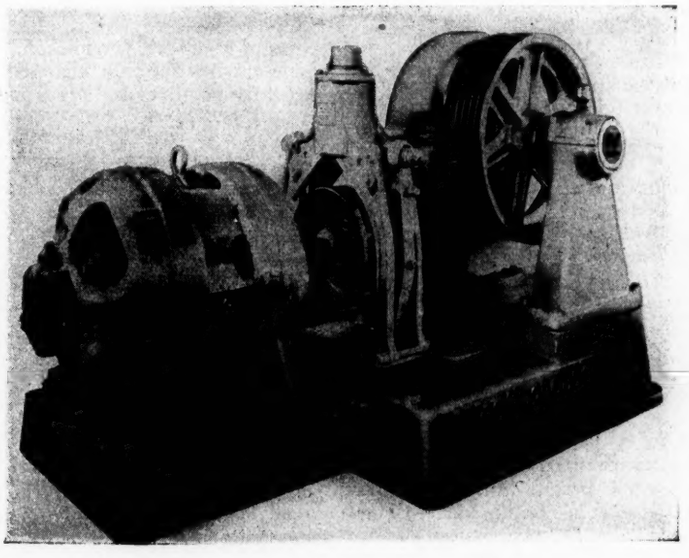
Stair treads are made up of the standard floor grating with a special support at each end which is welded on in a loop form, as shown in Fig. 3, the object of the loop being to have a double support or safety factor in supporting the tread. The loop is preferable to an angle because it leaves no shelf on which dirt can accumulate. Across the front edge of the tread is welded a straight bar the same depth as the rest of the bars in the tread, plus the depth of the loop support. Should any strain be induced in the stair tread itself because of a tendency for the stair stringers to spread, the double welding line of the loop will give the necessary factor of safety.

Direct-Current Control Used on A.-C. Elevators

DIRECT-CURRENT solenoid brakes and magnets are quiet, but frequently alternating current is the only power available. To get rid of the noise of alternating-current elevator brakes and control magnets, the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa., uses a copper-oxide rectifier, or Rectox, to supply direct current for these purposes. Passenger elevators, particularly the ordinary alternating-current geared type in apartment houses, are greatly benefited by this arrangement.

Direct-current brakes and control are easier to design, simpler to build and to maintain than those that operate on alternating current. The rectifier makes possible the combined advantages of direct-current auxiliaries and the simple alternating-current geared elevator.

The Rectox is an electronic and not an electrolytic rectifying device. It is silent and of substantial construction and may be applied without complicating the control.



Geared traction elevator machine with direct-current brake

FROM AMONG THE READERS'

Conducted
By
L. H. Morrison

Efficiency of an Economizer.—*How can we find if our economizer is operating efficiently?* J.P.P.

A practical efficiency exists when the economizer is delivering sufficient feed water at the desirable temperature, for this is all the economizer can do. A technical or theoretical efficiency would be the ratio of the heat put into the water and the total heat in the flue gas as measured above room temperature.

Heat Transfer Through a Superheater Tube. — *What is a fair value for the heat transfer through the walls of a superheater tube?* W.O.C.

The heat transfer will vary widely with the rating at which the boiler is operated, with the furnace temperature and with the location of the superheater. Under usual conditions, a rate of transfer of 1,500 to 2,500 B.t.u. per hour per square foot of heating surface is to be expected.

An Internally Heated Steam Engine.—*Is there any steam engine now being built that makes use of a hollow piston into which live steam is introduced?* A.R.B.

The Prosser engine employs a steam-filled piston on the grounds that this will prevent cylinder condensation where used in conjunction with a cylinder jacket. At present a 2,600-hp. Prosser engine is being installed on a lake boat at Buffalo, N. Y. The claim is made that with this particular engine the coal rate will not exceed one pound per shaft horsepower-hour.

Effect of Vacuum Jackets.—*If a vacuum jacket is placed around a vessel to decrease the heat absorption, does the width of the vacuum space have any influence on the rate of heat absorption? Will the loss be greater with the larger vacuum space if the walls be silvered to eliminate radiation?* G.R.L.

If two vessels be of the same diameter, with one inclosed in a vacuum jacket of a diameter 3 in. greater, and the second in a jacket 30 in. greater in diameter, with the same absolute pressure in each jacket, the rate of heat absorption will not be the same. However, contrary to what might be expected, the rate is greater with the larger vacuum space. This is because the heat absorbed is conveyed by the air molecules in the vacuum space, from the outer wall to the inner wall. In the larger space a molecule, after striking the outer wall, rebounds, but on account of the relatively small inner vessel surface, misses the inner wall and, sweeping across to the opposite outer wall, rebounds again, probably several times before the inner wall is struck. The molecule then strikes the inner unit at a velocity practically equivalent to the outer wall temperature.

In case of the smaller vacuum jacket the molecule, upon rebounding, cannot avoid the inner wall, and as the molecule does not attain a velocity equivalent to the outer wall temperature on one contact, actually less heat reaches the inner vessel walls. But this paradox occurs only when there is a large difference in the sizes of the jackets and practically the large vacuum jacket will give the better result.

Acidity of Feed Water.—*Somewhere I have read the statement that when a feed water is acid its pH value is low. What does pH mean?* W.A.P.

When water is acid it contains more free hydrogen than when alkaline. For example, when very acid $\frac{1}{1,000,000}$ of a given amount of water may be hydrogen ions, or the hydrogen portion is 10^{-6}. If neither acid nor alkaline, the hydrogen will be $\frac{1}{10,000,000}$ or 10^{-7}. If alkaline, the hydrogen is less, say $\frac{1}{100,000,000}$ or 10^{-8}. The *pH* value, or parts of hydrogen per million, is the exponent with the sign changed, such as *pH* 8 for alkaline, and *pH* 6 for an acid.

Operating Frequency Changers in Parallel. — *Two frequency-changer sets operating in parallel between a 50- and a 60-cycle system, sometimes trip off the system on account of a disturbance. In all cases they trip off on the 60-cycle side and remain in parallel on the 50-cycle side. One set is first put back on the system and it takes from one-half to full load before the second set is put on the line. Is it safe practice to put the second set into service without reducing the load on the first to near zero? Will the machine divide the load equally between them, if they are of equal capacity and design? The machines are located about five miles apart.* E.L.F.

There should be no objection to connecting the second frequency-changer set to the line when the first is in operation and is loaded. After the two sets are in parallel the load should be divided equally between them and then, if they have equal capacity and are of the same design, any change in load should divide practically equally between them.

If the motors are of the induction type, it is possible for a difference in voltage at the motor terminals to affect the division of load between the machines. Anything that can affect the speed regulation of the motors could cause an unequal division of the load. For example, if the bars in the rotor of one motor were not making good connections with the ending, this motor would tend to shirk its load.

Coloring Matter in Water.—*In our bleachery we use sand filter beds to clarify the water. These beds work satisfactorily for a while and then the water has a slightly red color. The filter sand seems to be colored with a red clay that was originally in the raw water. How can we remove the red substance from the sand?* L.C.W.

Back washing will not break loose the clay, and about the best way is to add caustic soda to the water in the bed and let it remain for 24 hours. This caustic-soda solution will loosen the clay and back washing will clean it out.

Diesel-Driven Triplex Pump. — *Our city water pumps are motor driven, but the high cost of current has prompted us to investigate the oil engine. It is claimed by some that the plan of driving a triple pump with an oil engine is not a good one, for at light rates of pumping, the engine would have to be run at half-speed, which, so it is claimed, is inefficient.* A.M.A.

The Diesel at half-speed will have a fuel consumption per brake horsepower-hour practically the same as at rated speed. However, if the town has a stand pipe or elevated water tank, as it should with triplex pumps, the engine can be run at full speed until the storage is filled, and then be shut down. Alternating-current motors run at constant speed, so if they handled the pumps satisfactorily the engines should.

Work of Oil-Engine Pump. — *What is the work used by the injection pump of a solid-injection engine?* M.O.V.

Let it be assumed for example that the design of the fuel system calls for a pump discharge pressure of 5,000 lb. per sq.in. An engine will use about 0.45 lb. of fuel per horsepower-hour, or approximately 16 cu.in. The work done by the pump per hour is then $VH = \frac{16}{12} \times 5,000 = 6,666$ ft.-lb. But the kinetic energy of the oil spraying into the cylinder is returned to the engine. The energy so released is that due to the pressure drop to 500 lb. cylinder pressure, or $\frac{16 \times 5,000 - 500}{12} = 6,000$ ft.-lb. The actual pump loss is then 666 ft.-lb. per hour per horsepower.

PROBLEMS

ANSWERS

from Our Readers

THE QUESTION

WE ARE planning to install a 50-ton ice plant, the machine to be driven by direct-connected oil engines. The demand varies and we would like to know the better choice: two compressors driven by two engines, or a single machine driven by one engine which at times of low demand will be run at half speed. C.F.X.

FROM the standpoint of reliability it is better to install two duplicate compressors, each with its engine. From the viewpoint of operation at partial capacity during mild seasons and light load periods, it is better to operate one small machine with one in reserve to be operated when necessary. The saving in wear and tear will more than offset the slightly higher efficiency of the large set.

From the viewpoint of maintenance it is better to have two machines, on account of the smaller parts that will have to be handled. At the time of repairs only one-half of the capacity need be out of service and only one set of spare parts need be kept on hand.

The two duplicate machines will produce ice cheaper than the one large unit operating with a varying load during the year. From the investment viewpoint the duplicate machines will possibly cost 10 to 15 per cent more than the single unit of the same total capacity, but the cost of the spare-part stock for the large unit will be more than for the smaller ones. When the actual equipment costs and ice output estimates are obtainable, this can be easily figured out.

St. Louis, Mo. JESSE L. BEST.

THE determining factor in the choice of units for a 50-ton ice plant is the load factor.

If the plant is to be run at full or nearly full capacity most of the time, a single machine equipped with clearance pockets would be the better choice. Opening one set of clearance pockets would reduce the capacity 25 per cent and opening all clearance pockets would reduce the capacity 50 per cent, with no appreciable loss in the compressor efficiency in either case.

Any expected demands on the plant that would require an increase in capacity in the next two or three years would favor the single machine, with the installation of additional capacity to take care of the additional load.

However, if the demand is to be less than 50 per cent of the capacity most of the time, the capacity should be divided into two machines; and one or both of them should be equipped with clearance pockets, depending on the variation in the load.

The additional cost of adding clearance pockets in new machines is comparatively small and in most cases will soon be returned in power savings.

Oil-engine efficiency at 50 per cent load is only about 10 per cent lower than at full load, but falls off rapidly as the load drops below this point. The plant should be designed if possible to maintain better than 50 per cent load on the oil engines at all times.

H. N. ROYDEN.

Los Angeles, Calif.

FROM the point of view of first cost the single unit installation is far better, since there will be a saving in the cost of the machinery and foundations, as well as some saving in building construction.

On the other hand, two separate units offer the most flexible type of plant and, of course, would insure protection against total shutdowns.

As to the operating economies, there would not be a great deal gained either way, for the fuel consumption of the Diesel engine does not vary materially from one-half load to full load and the volumetric efficiency of a 25-ton machine is fairly close to that of the 50-ton machine.

Probably the best method to arrive at the correct solution of this problem would be to obtain bids on specifications for a two-unit plant and for a single-unit plant and then develop a cost schedule showing the total cost of the two plants, including buildings, foundations and machinery.

At the same time a comparison could be made of the guaranteed efficiencies of the two small units as compared with the one large unit, so that it would be possible to determine the operating cost per month based on a knowledge of the monthly load factor.

My personal opinion is that when the overhead charges are applied to the additional investment required for two small units as against one large unit, it will be found that it would pay to install the one large unit, having the compressor equipped with clearance pockets so that the capacity of the compressor could be reduced during periods of low load factor.

Of course this presupposes the installation of a horizontal double-acting compressor. C. T. BAKER,
Consulting engineeer.

Atlanta, Ga.

SO FAR as efficiency is concerned, there is little difference between two compressors driven by two oil engines and a single compressor driven by one engine which at times of low demand will be run at half-speed. When the plant output exceeds 75 per cent of rating, the single machine will be slightly more efficient; below that and particularly below 50 per cent output the two-unit plant will do somewhat better.

However, a more important factor than efficiency is the need of providing reliable electric power for driving the auxiliaries, particularly the air-agitating equipment and the condenser-water pumps. If the water supply to the condensers fails, the compressors must be stopped. If the air-agitating equipment ceases to function, a tankful of "tombstones" will be produced. It is highly desirable, therefore, to have two independent sources of electric power.

A good practical arrangement would consist of two 135-hp. oil engines, each direct-connected to a 25-ton compressor and to a 40-kw. generator.

EDGAR J. KATES,
Consulting Engineer.

New York City.

A Question For Our Readers

WHEN an industrial plant load fluctuates widely by reason of steam-hammer operation, does pulverized-coal equipment work out more or less satisfactorily than do stokers? R. P. P.

Suitable answers from readers will be paid for and published in the May 21 issue.

Building Sheet-Metal Guards

This article, reproduced from a recent number of *Oxy-Acetylene Tips*, shows how guards for belts and gears may be fabricated in the plant by means of the cutting and welding torches.

WHEREVER there are exposed belts and gears, some means should be taken to prevent accidental contact with them.

Various types of guards can be easily made by welding in the shop. The accompanying sketches illustrate two types of safety guards for machinery which can be fabricated in the shop during the welder's spare time and as need for them may arise.

The first type of guard illustrated (Fig. 1) is for machines run from overhead shafting by means of belts. The measurements can be made according to the size of the machine. The distance from *A* to *B* should equal the distance from the floor to the center of the driveshaft of the machine. The distance from *A* to *C* should be about five feet in order to prevent an ordinary-sized man from coming in contact with the exposed belting. From *A* to *D* should equal the size of the driven pulley plus sufficient clearance so that the guard can be easily moved away to replace a belt. The width of the guard (*D* to *E*) should be sufficient to clear the pulley.

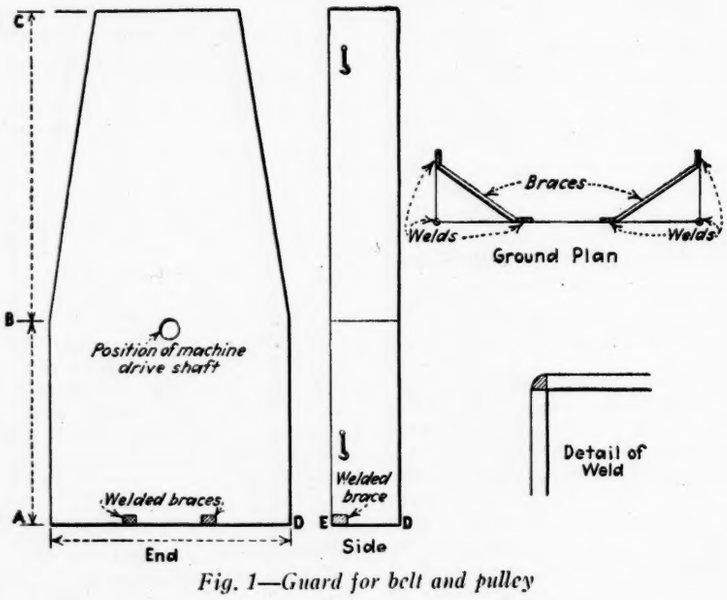


Fig. 1—Guard for belt and pulley

Sheet Steel Used

For a guard of this sort sheet steel about one-eighth inch thick should be used. The larger section and the two side strips can be cut out with the oxy-acetylene blowpipe according to measurements obtained. Care should be taken that the bottom lines *A* to *D* and *D* to *E* are exactly square so that the guard will stand level on the floor. One side strip is first tack-welded at *A* and then at intervals along the side. This insures a strong corner weld. If necessary the strip can be heated at *B* and bent to fit the angle. The same procedure is carried out on the opposite side. Then the two seams are welded along the entire length. Brackets or braces can be placed across the bottom of the guard as shown in the smaller diagram. Two hooks should be placed on the top and bottom of each side, as shown, or some other means taken to fasten the guard in position against the machine.

The gear guard shown in Fig. 2 is made for either chain drive or gear drive. It also is made from $\frac{1}{8}$-in. sheet steel, and can be cut out to fit the contour of the drive mechanism. The edge on each of the sides *A* and *B* is then measured and a side strip cut. Tack welds are made along the edge and the side piece bent to fit the curve. This type of gear guard is designed to be supported either on an angle-iron framework or bolted to the end of the machine, and is made with a hinged top.

Making The Hinges

The method of making the hinges is shown. Four pieces of $\frac{1}{4}$-in. plate about 3 in. long and 1 in. wide are cut out with the cutting blow-pipe. Two of these are made with rounded ends, as shown in the diagram, and on the other two the ends are square. In the rounded ends a $\frac{1}{4}$-in. hole is cut; this is also done to one end of each of the other pieces. Fillet welds are made around the sides of the pieces, with the rounded ends, while they are in position, extending about an inch beyond the edge of the upper half of the guard *A*. The pierced ends of the other hinge straps are placed flush with the edge of the lower section of the gear guard *B* and fillet-welded to the end plate. Two $\frac{1}{4}$-in. stove bolts are placed through the two holes and tightened. They should hold the top half of the guard so firmly that it can not be accidentally knocked out of place.

If desired, an angle-iron framework can be made to hold the lower part in position. The upper section *A* can then be opened whenever it is necessary to grease or inspect the gears.

The adaptability of the cutting and welding torch to the fabrication of sheet metal and the fact that much work of this sort can be done by the regular staff in spare moments is increasing the use of sheet metal in the plant. Machine guards of all kinds are particularly suited to this type of construction.

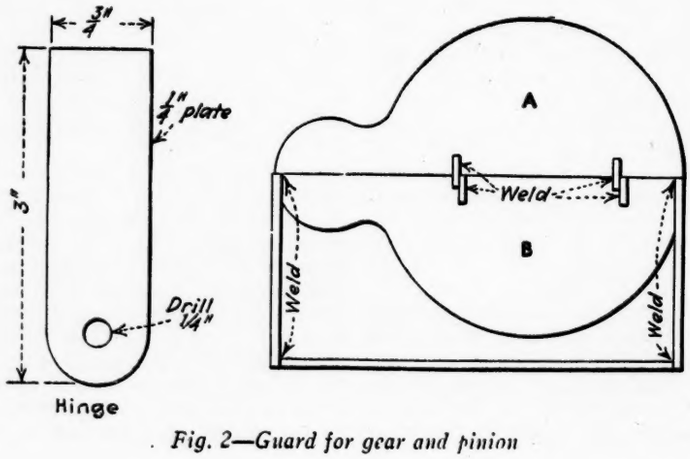


Fig. 2—Guard for gear and pinion

Pulverized Coal in Small Plants

Progress in Unit Mills, Short-Flame Burners, Air-Cooled Walls and Dust Recovery

AT THE Indiana Fuel Conference, held April 4 and 5 at Purdue University, Lafayette, Ind., Vernon Leach, combustion engineer for the Peabody Coal Company, presented an interesting address on the foregoing subject. The ideal conditions for pulverized coal made possible in the central-station plant by the installation of elaborate and expensive equipment could not be reproduced in the small steam plant owing to prohibitive cost.

Here the operator was limited to such equipment as would be justified by the saving in coal that reasonably could be expected. Recent development of relatively inexpensive and at the same time serviceable equipment is bringing pulverized coal into the small boiler plant. Great progress has been made in the development of the unit pulverizer, the short-flame burner, air-cooled walls and in simple methods of dust recovery.

Preheated Air With Illinois and Indiana Coals

By far the greatest improvement in unit pulverizer practice has been the use of highly preheated air in the mill. Air, preheated to as high as 600 deg. F., is being used with Illinois and Indiana coals, where as much as 30 per cent of the air for combustion is taken directly through the mill. In some cases drying of the coal in the mill has tripled the life of the wearing parts, such as the hammers and the liners.

It appears that when a particle of high moisture coal is introduced into an atmosphere of hot air, the moisture is vaporized with sufficient violence to disintegrate the particle and thus, to a large extent, assist in pulverizing it. The moisture content of the fuel, of course, would be the controlling factor in determining the maximum air preheat that should be used. So long as moisture remains in the coal during the pulverizing process, it would be impossible to heat it above the dew point and therefore no tars nor volatile gases would be driven out of the coal while in the pulverizer. The temperature of the air-coal mixture delivered to the burner should be in the neighborhood of 200 deg. F., as this temperature is favorable to quick ignition and short flame.

Coal and Air Regulation Produces Steady Flame

Another important improvement in the unit pulverizer has been the development of accurate coal and air regulation, producing steady flame conditions and uniform CO_2. Renewal of wearing parts, such as hammers and fan blades has been simplified, although this improvement by no means has been universal. In one type of mill hammers might be renewed in as short a time as eleven minutes, while in another mill the time required might be as long as three hours. Most unit pulverizers are being designed to minimize or entirely eliminate damage resulting from tramp iron or other hard substances in the coal. In fact, everything possible is being done to increase the reliability, the accessibility and the efficiency of the unit type of pulverizer.

One of the chief elements that is making pulverized fuel available to the small plants is the development of an inexpensive type of short-flame burner. By lantern slides the author illustrated a burner of his own design that would function under widely fluctuating loads and adverse conditions, such as large percentage of primary air and coarse grind. To avoid slag accumulation on side walls, the flame was projected in a controlled path.

It was obvious that from cost considerations the small plant owner must forego the advantages that could be derived from water-cooled walls and floors. Certain air-cooled furnace walls are now available that will absorb as high as 6,000 B.t.u. per square foot per hour. These wall designs cost but little more than the old-fashioned solid construction and have three or four times the cooling power of the earlier type of air-cooled wall. In the properly designed small plant, all the air for combustion should be passed through air-cooled walls and floors, thus furnishing a convenient supply of hot air for drying the coal.

Small Heat Storage of Walls an Advantage

Another important advantage is the small heat storage in the wall itself, which permits the boiler to reach quickly its maximum efficiency after long banking periods. Solid-wall structures and the older type of air-cooled wall required several hours' operation under full load before all the heat being liberated would be available for absorption in the boiler.

Five simple methods of dust elimination that had been developed recently were illustrated. Two methods in particular were stressed—one in which the apparatus served the dual purpose of an induced-draft fan and a dust collector, and the other was the dust-collecting breeching. Here the gases from the boilers were delivered tangentially to opposite sides of a circular breeching, so that they would be given a whirling motion that would bring most of the dust to the outer circumference. A projecting longitudinal plate skimmed the dust into a receptacle at the bottom of the breeching, from which it was transferred to storage. The gases to the stack were drawn off from the center of the breeching, where the dust content was lowest. Fully 60 per cent of the dust and ash from the burning of powdered coal had been recovered at this point.

Indiana Boiler Laws vs. A.S.M.E.

IN 1911 the State of Indiana enacted a set of boiler laws providing for the construction, inspection and installation of steam boilers and the use of certain safety appliances on these boilers. Four years later an amendment was passed and incorporated in section 10 of the ordinance to the effect that boilers built to the standard of the A.S.M.E. Code would be acceptable to the State of Indiana.

It will be noticed that while boilers were mentioned specifically, nothing was said of boiler appurtenances. Since 1915 the Indiana boiler laws have remained unchanged and in compliance with the amendment boilers built according to the A.S.M.E. Code have been accepted. Operating under two sets of regulations differing in certain requirements, and with doubts as to the appurtenances, has been a source of confusion for years among boiler manufacturers and others having connection with the boiler field.

Safety Valve Area

One of the appurtenances causing no end of discussion has been the safety valve. Section 12 of the Indiana laws requires that the "area of such valves, when used on boilers, shall be in the proportion of 1 sq.in., of valve for every 3 sq.ft. of grate surface." The A.S.M.E. Code makes the lift of the valve the prime factor in relieving capacity. The two requirements were at such variance that they could not be reconciled, and confusion continued until late in 1928, when the Industrial Board of Indiana ruled that the intent of the law would accept appurtenances, as well as boilers, agreeing with the A.S.M.E. Code.

Another point of difference was in the support of return-tubular boilers. Section 11 of the Indiana law states that all boilers 54 in. and above in diameter shall be suspended and not rest on walls. All boilers less than 54 in. in diameter may be suspended or supported by two brackets or lugs on each side of the boiler. The A.S.M.E. Code permits boilers 54 to 78 in. in diameter to be suspended or set on brackets. In this case the Industrial Board ruled that heating boilers—that is, boilers carrying a steam pressure of 15 lb. or less—could be set according to the code, but that power boilers must be set according to the requirements of the Indiana law given in this paragraph.

These rulings have helped to straighten out the tangle. The present practice of the state boiler inspector is to accept boilers bearing the A.S.M.E. or National Board symbol and also to accept the appurtenances on these boilers that follow code requirements. Boilers not bearing these symbols must comply with Indiana state regulations, and naturally the Indiana law also applies to the appurtenances. The foregoing practice applies to both power and heating boilers.

A second-hand boiler entering Indiana

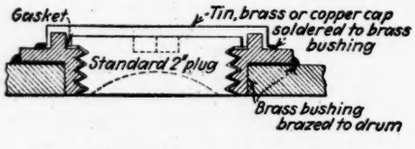
from another state must bear the A.S.M.E. or National Board symbol or be accompanied by an affidavit from an official of the company that built the boiler, setting forth the facts that the boiler in question was built according to the rules of the A.S.M.E. Code of construction. Accompanying this affidavit must be sufficient facts to establish the identity of the boiler beyond the shadow of a doubt. Also there must be an inspection report from the deputy inspector of the State of Indiana, or from an inspector of an insurance company doing business under the laws of the state, showing the present condition of the boiler.

From the various rulings of the Industrial Board given previous mention and the fact that the board accepts the latest interpretations of the Boiler Code Committee of the A.S.M.E. on any points not covered by the Indiana boiler laws, the drift apparently is toward the complete acceptance of the A.S.M.E. Code and the nullification of the present state boiler law. No such action can be taken before 1930, but it would seem desirable that a standard set of regulations quite generally adopted by other states and kept continuously up to date should be adopted and permitted to function unhampered by a set of state regulations drawn up in 1911.

Moisture-Tight Containers for Transformer Oil

IN THE March issue of the *N.E.L.A. Bulletin*, J. E. Busher, superintendent, Electric Station Construction, Kansas City Power & Light Company, says:

Transformer oil shipped in drums is likely to absorb moisture during shipment or storage. This is readily admitted by the manufacturer, who claims



Moisture-proof bushing for oil container

that with the present type of seal on oil drums, it is impossible to seal out moisture and the only way oil can be shipped to insure a high dielectric strength is in tin containers with a soldered seal.

Our experience during the last year has been that transformer oil received in drums in most cases has shown a very low dielectric strength due to the fact that moisture was present in the oil. Fortunately, it has always been our policy to test the oil before it is put into electrical apparatus. Possibly some of the smaller companies do not make this check, assuming that the oil as received from the manufacturer is in good condition.

I feel that where this has been done, oil with too low a dielectric strength has, in a good many instances, been put into high-voltage apparatus. Operating companies and industries using transformer oil should insist that such oil be shipped in containers that will absolutely guarantee the oil being received in a condition suitable for immediate use without any doubt as to its high dielectric strength.

Oil that we tested after shaking the drum up and taking a sample out of about the middle of the drum has broken down, under test, at as low as 10,000 kv. It is our practice never to use oil with a lower dielectric strength than 22,000 kv. and the bringing of the oil up from 10,000 to 22,000 kv. has caused considerable expense and annoyance, which could have been avoided if the oil drums had been properly sealed.

The diagram shows how this could be done by the manufacturer so that oil with a high dielectric strength can be insisted upon by the operating companies, which I feel should be done.

Decomposition of Lubricating Oils

AT THE 1928 General Meeting of the Association of German Chemists at Dresden, Doctor Baader, of the Goldenberg Electricity Works, Cologne, discussed a new method of determining beforehand the tendency of switch and steam-turbine oils to gradual decomposition.

Doctor Baader emphasized the practical importance of testing these oils as to their tendency to decomposition and then explained that all other methods in use cannot give satisfactory results. They are devised to determine in one single test the effect of all the stresses to which an oil is subjected, such as high temperature, attacks of air or oxygen and the chemical interaction between the oil and metals, and thus only determine the combined effect of all these deteriorating agents. A test of this kind is unsatisfactory, both for those who use and for those who manufacture the oil. In case an oil proves unsuitable for its intended purpose, the user and the manufacturer wish to know why it is unsuitable and to what particular stress the premature decomposition is due.

The new method allows of testing an oil against the attacks of any decomposing agent to which it is subject in practice. Each oil is tested in several samples, as to its resistance to the separate influence of various stresses. As a rule the resistance of an oil is tested against high temperature and against the influence of copper and of lead, but the tests can be extended to other metals and to insulating materials.

The metals are introduced into the testing apparatus in the form of small spirals prepared by the operator himself and used once only. All artificial stresses to which the oil is not subjected in practice, such as heating beyond the operating temperature or passing of oxygen through the oil, formerly used to accelerate decomposition, are excluded.

The time required to make an efficient test is only 48 hours. This advantage is gained by keeping the oil in continual movement, a means of enhancing the effect of the stress which has been neglected in the other testing processes. By the continual movement the action of the air and the metals on the oil is greatly intensified. The spirals are moved up and down in the oil by means of a stirring mechanism 25 times per minute. Oils thus artificially stressed are then tested for their saponification number, and this feature, which as a test has hitherto been rather neglected, has proved to be a very delicate indicator of the initial stages of decomposition.

A series of tests carried out on 24 new and regenerated insulating and steam-turbine oils by means of this new testing method, using apparatus supplied by Heinrich Faust, of Cologne, showed that the method brings out the peculiarities of the different kinds of oil and that the commercial brands differ markedly in their tendency to gradual decomposition. The new testing method is therefore well adapted to meet the requirements of practice. In the case of steam-turbine oils the results of the new testing method have been found to agree with the results of long-time tests in running engines, in which the gradually progressive decomposition of the oil was checked by making quantitative tests.

The tests show the influence of the duration of the treatment and the height of the testing temperature and throw light on the corrosive action of oil on the different metals. The results of parallel tests carried out with the same oil agree well with each other.

In conclusion Doctor Baader remarked that the results of the new testing method tend to show that the prevailing views on the gradual decomposition of oils will have to be thoroughly reconsidered. It would seem that the inadequate testing methods hitherto in use have proved positively misleading.

Paper Company System Output

INTERNATIONAL Paper and Power Company system, according to the *International Paper Monthly*, produced 344,573,000 kw.-hr. of electric energy in February, an increase of one-third over the output of the system in February, 1928. In the first two months of this year the company generated 723,350,000 kw.-hr., an output 36 per cent greater than in the corresponding period of last year.

Included in the foregoing are the output figures of the New England Power Association, the Canadian Hydro-Electric Corporation, Limited, which controls the Gatineau Power Company and Saint John River Power Company, and of the hydro-electric plants of the International Paper Company group.

Events and Men in Power's Field

THE EDITORS WILL WELCOME THE CO-OPERATION OF READERS IN REPORTING INTERESTING HAPPENINGS, PERSONAL OR OTHERWISE

N.E.L.A. Survey Shows Growth of Power in 1928

Net Gain in Business Has Been Carried by Steam Plants

SUBSTANTIAL gains in several directions were made by the electric power industry last year, according to a statement issued by the statistical and research department of the National Electric Light Association. The summarization of the individual months of 1928 made possible by the co-operation of some 400 companies, gives preliminary figures for several of the more important statistics of the year's operations.

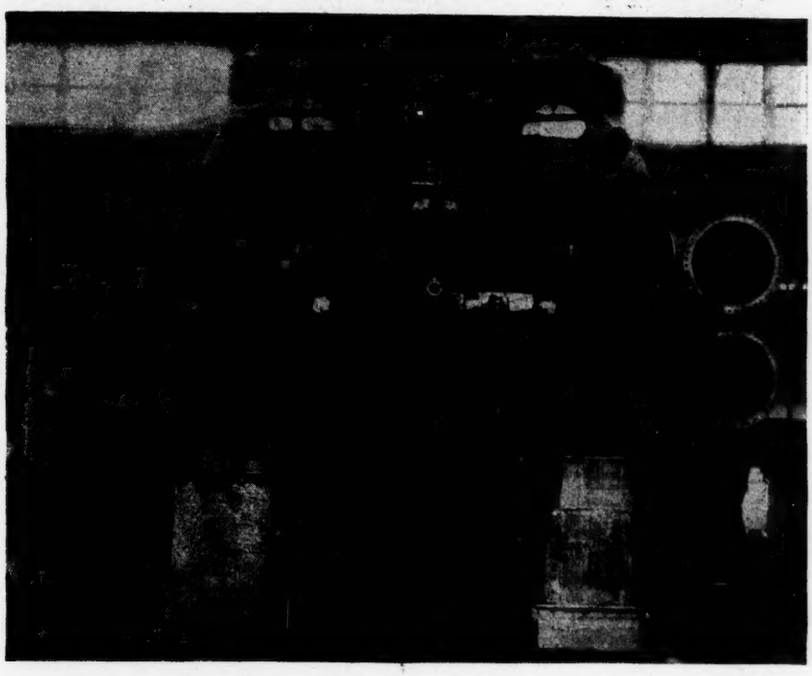
While the continued expansion of facilities and the further diffusion of service to all classes of consumers was a feature of public-utility operation in 1928, an analysis of these trends discloses some interesting facts. The actual generation of energy by the electric light and power industry itself increased during 1928 by 7,545,000 kw.-hr. (or by 10.1 per cent) over the generation during 1927, as compared with an increase of 6,560,000,000 kw.-hr. (or by 9.7 per cent) in 1927 over 1926. Some qualifications must, however, be immediately made in this comparison. February had one more day in 1928 (which accounted for 220,000,000 kw.-hr.) and some of the gain was at the expense of power imported from Canada and purchased from enterprises not public utilities. Eliminating the extra day, the net gain in the grand total of electricity, generated and purchased by the electric light and power enterprises of the United States during 1928, was 6,973,000,000 kw.-hr. (or of 9.1 per cent) over 1927. This compares with corresponding figures of 7,573,000,000 kw.-hr. (or of 10.9 per cent) in 1927 over 1926 and with approximately 8,200,000,000 kw.-hr. (or 13 per cent) in 1926 over 1925. These comparisons again emphasize the importance of the fluctuations of the activity of industry and trade in the fortunes of the electric light and power business. Conversely, the amount of activity in the power business indicates general industrial conditions with fair accuracy.

For this year the production of electricity during February by all the agencies which contribute to the country's supply, was 7,444,318,000 kw.-hr. This is an increase of 573,759,000 kw.-hr., or 8⅓ per cent, over the same month last year, which, however, had one more day. In addition to this February, 1929, total a further amount of 110,645,000 kw.-hr. was imported from Canada.

The production of electricity by water power during February was less than that of the same month in 1928. During the first two months of the year 150,000,000 fewer kw.-hr. have been generated by hydro-electric stations than during the same months of 1928 and all the net growth of the business has been carried by steam power plants.

The ratio of the production of hydro-electric energy to the total output remained at 33 per cent, the low figure of January. The extremely wide fluctuations in this water-power ratio, from the high point of 45 per cent in May, 1928, to the current figure of 33 per cent, shows the effect of the variations of precipitation and stream flow upon the possibilities of hydro-electric output and the increasingly important part that steam plants must play in providing for the growth of the country's demand for power.

The increase in the production of electric power has been accompanied by a striking decrease in the number of power plants. During a period of five years between 1922 and 1927, the number of plants decreased by 19 per cent. At the same time, however, the average size of generating plants has doubled during that period.



A new condenser for one of the New York Edison plants. It has 90,000 sq.ft. of cooling surface and will condense 700 tons of steam an hour. The little fellow hanging from the crane has 1,200 sq.ft. of condensing surface.

Hotel Engineering in Cornell Summer Curriculum

Two courses in hotel engineering will be given at Cornell University during the 1929 summer sessions. Although these courses have been an integral part of the four-year curriculum since its inception in 1922, this will be the first time that they have been offered to short-course men. Prof. Frank H. Randolph, a member of the four-year staff, will be in charge of the summer engineering instruction.

The first of the summer engineering courses for those employed in the hotel industry will open on July 8 and close on July 27. This course is a general one and is for owners, managers and front office men who seek a knowledge of the engineer's problems. It is desired to impart a general understanding of the principles employed in plumbing, fire protection, communication systems, kitchen appliances, laundry machinery, vacuum cleaners, electric lighting, elevators, mechanical refrigeration, low-pressure boilers, heating and ventilating systems.

The second summer engineering course will be chiefly technical. It will open on July 29, and continue until Aug. 17. This course is planned by the Cornell authorities for the students

with some previous experience in the engineering department and who desire to broaden their knowledge along technical lines so as to enable them to secure better operating economy.

Considered in this course will be power plants, auxiliaries, methods of detecting and checking waste in the boiler and engine rooms, fuels, combustion, flue-gas analysis, firing methods, feed-water purification, boiler meters, methods of boiler testing, valve setting, indicator cards, reciprocating and centrifugal pumps.

Last summer saw the first opening of the three-week courses for those already employed in the industry. These courses are without formal entrance requirements and the tuition is kept at a minimum. Twenty-eight young men from twelve different states took the time to go to Cornell last summer. During 1929 many more are expected.

First Aluminum Crane Is Being Constructed

What is purported to be the first aluminum crane is being built by the Alliance Machine Company, of Alliance, Ohio, for the Aluminum Company of America. It is a 10-ton traveling shop crane, the main girders of which are being constructed of strong aluminum alloy. This use of aluminum will materially reduce the wheel load on the building and, it is expected, will also lower operating costs.

Upon completion the aluminum crane will be installed in the new structural shape mill at the Aluminum Company's Massena Works. At the same time it is planned to install a duplicate of this crane built of steel in the blooming mill at Massena, so that direct comparisons of operating expenses can be made.

Heating-Ventilating Engineers to Meet in Canada

The American Society of Heating-Ventilating Engineers has received this year an invitation from its Ontario Chapter to "Come to Canada." Accordingly, the 35th semi-annual meeting will be held in the highlands of Ontario, at Bigwin Inn, Lake-of-Bays, on June 26-28, under the direction of the Canadian members.

This is the first time in the society's history that the meeting has been held outside of the United States, and the Ontario members are anxious to have one of the largest summer meetings ever held. M. Barry Watson, chairman of the Meeting Arrangements Committee, announces that Bigwin Inn offers unusual facilities for outdoor recreation amid beautiful natural surroundings.

The program for the technical sessions of the summer meeting is under the direction of a committee, headed by H. H. Angus. No announcement of the subjects has been made as yet, but an excellent list of papers is promised. The technical sessions will be held from 9:30 a.m. to 1 p.m.

Spot * News

MARCH SALES *of mechanical stokers, as reported to the Department of Commerce, totaled 117 of 42,432 hp., as compared with 80 of 31,554 hp. in February.* * * *

A REPORT FROM LONDON *states that the Parent Coal Carbonization Trust, Ltd., has been formed with a capital of £750,000 to acquire the rights for Great Britain of the Aicher low-temperature carbonization process. The trust plans to finance the erection of plants and rotary ovens at selected British collieries. Cannel coal, it is claimed, is specially suitable for treatment by the Aicher process, and a contract for the supply of 5,000,000 tons has been made.* * * *

A SUDDEN THUNDERSTORM *which swept over New York City on the afternoon of April 4 added 300,000 kw. to the Edison companies' load, bringing a record peak of 1,014,400 kw. at 3:45 p.m.* * * *

THE 1929 BUDGET *of the Puget Sound Power & Light Company, Seattle, originally placed at $9,000,000, has been increased by $2,500,000 because the company has decided to install the second 50,000-hp. steam unit in its new Shuffleton plant near Renton, Wash.*

* * *

A BID FOR MUSCLE SHOALS' *plants will be submitted to Congress during the present special session, according to J. H. Reid of Washington, engineer for the Farmers' Federated Fertilizer Corporation. Mr. Reid said the company making the bid would have a capital of $200,000,000 and would manufacture fertilizer to be sold to the farmers at cost.*

* * *

THE SHANGHAI *International Settlement on April 17 voted by a large majority to accept the American & Foreign Power Company's bid for its municipal electric plant.*

* * *

O. C. MERRILL, *executive secretary of the Federal Power Commission, told the engineering student body of Princeton University in an address on April 16 that the use of steam plants is favored as a source of energy in the future, owing to the mechanical limitations in water-power apparatus.*

* * *

TO DISCUSS *the industrial and public safety problems of the Central States, at least 2,000 delegates are expected to meet at Kansas City, Mo., on April 30 and May 1. This conference will be officially known as the Third Annual Central States Safety Congress.*

* * *

POWER LINES *were severely damaged by a furious gale which swept Ontario, Canada, recently. Electric service in many parts of the province was disrupted with a consequent loss to industries and a general tie-up in business.*

World Power Conference Publishes Survey

The first authoritative survey of world power resources, potential and developed, has been published in book form in London under World Power Conference auspices. This study has been compiled and condensed by the British economist, Hugh Quigley, from past Conference proceedings and from an extensive bibliography listed through 75 pages of the book. O. C. Merrill, executive secretary of the Federal Power Commission, considers the work as the best of its kind in print.

This monograph undertakes an outline of existing knowledge regarding all power resources, notably coal, oil, gas, hydro-power, and electricity. It discusses the difficulty of getting comparable data and the necessity of establishing certain statistical standards so that information from different countries will be on a comparable basis. The preface points out that tabulations of the international reserves of hard coal, brown coal, oil and water power will give a key to the economic utilization of these resources.

Through a special arrangement, copies are being imported duty free and are being made available at cost in limited quantities. Copies may be bought at $4.25 postpaid through the office of the Federal Power Commission in Washington, D. C., or through a member of the American Committee of the World Power Conference.

Electric Power Increases Efficiency of Mines

While the problem of overproduction in the coal industry remains unsolved, notable progress is being made on the engineering side. If consideration is given the revolutionary advances in methods of mining, in the preparation of coal, in storage practice and in efficiency in utilization, it can be said that more progress has been made in the last fifteen years than in any previous period in the history of the industry.

In the field of underground production the period since 1913 has seen the beginning of a great mechanical epoch. Mine power has been electrified. Larger and larger electric shovels have been put to work in connection with open-pit mining. As a result the tonnage recovered by stripping operations has increased from 1,200,000 to 18,500,000. The Colstrip Mine of the Northwest Improvement Company has reached an output of 58 tons per man per day.

In the underground mines hoists and tipples now are electrified in all but the older districts. The State of West Virginia uses only four-tenths of one per cent of the coal mined for mine power. Practically every mine of importance is buying electrical power from central stations.

Underground the electric locomotive has become the dominant type of haulage equipment. It virtually has eliminated steam, gas and compressed air

and is fast driving out the mine mule. In the same way the electric cutting machine has displaced its air-driven competitor, and with power carried to the working face, electric drilling of shot holes becomes feasible and rapidly is being introduced.

With haulage, cutting and drilling already electrified, or about to be, there remains only the heavy labor of shoveling coal from the floor to the mine car. To do this by human muscle at the union wage scale is equivalent to paying $10 per kilowatt hour for the energy expended. This staggering element of cost has provided an incentive to the inventive genius of the country which is now busily studying the problem of eliminating hand shoveling.

Westinghouse Company to Open Lighting Institute

Much interest has been aroused in electric utility and lighting circles by the Westinghouse Lamp Company's announcement, just made, that it is about to establish a lighting institute for the display of illuminating equipment—its competitors' as well as its own—and as a laboratory where any engineer can test lighting effects.

The institute will occupy an entire floor (more than 40,000 sq.ft.) of the Grand Central Palace in New York City and is designed to afford a working demonstration of the latest developments in illumination wherever applied. The appearance of streets, offices, factories, stores, show windows, theaters, schoolrooms, residences and garages has been simulated closely in the various subdivisions of the floor, so that every piece of equipment and every lighting effect will be seen in its natural environment, and control apparatus has been installed for each lighting unit. It is not intended to try to make room for every new piece of equipment, but many types constantly changing, will be shown and the availability of other types will be made clear.

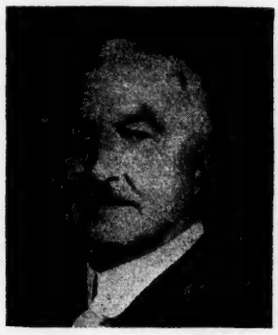
The exhibit will be directed by Ralph Neumuller, who is well known in the electrical industry, having formerly been manager of many advertising and merchandising activities.

Symposium on Boiler Chemistry at A.C.S. Meeting

At the meeting of the American Chemical Society to be held at Columbus, Ohio, April 29 to May 3, 1929, the Division of Gas and Fuel Chemistry will devote a session to a symposium on "Boiler Room Chemistry." This session will come on Wednesday, May 1, from 9 a.m. to 2 p.m.

Several of the papers to be presented on Thursday morning should prove interesting to power engineers. Among them are: "The Carbonization of Ohio Coals," "The Thermal Treatment of Natural Gas," and "A Simplified Apparatus for Determination of CO in Flue Gas."

Men in the News



MORTIMER E. COOLEY

past-president of the American Engineering Council, was presented with a certificate of honorary membership by the Detroit Section of the American Society of Mechanical Engineers at a dinner tendered him at the Michigan Union, Ann Arbor, on Friday, April 19. For many years Mr. Cooley was dean of the College of Engineering of the University of Michigan until he retired last fall. He was also in charge of hydro- and steam-electric properties of the Michigan Public Utilities Commission.

Gov. Roosevelt Signs Three Bills Affecting Utilities

Three bills, directly or indirectly affecting power companies, were signed recently by Governor Franklin D. Roosevelt, of New York. Two of these relate to the financing of steam corporations, and the third authorizes a study of the Public Service Commission.

The first bill to become a law was the Fearon act, which amends the public service commission law to include a gas corporation, an electric corporation or a gas and electric corporation among the corporations which may purchase, acquire, take or hold more than 10 per cent of the capital stock of any steam corporation.

The Thayer bill was the second amendment to the public service commission law. It provides that a steam corporation may issue stock, bonds or notes or other evidences of indebtedness for the acquisition of property; the construction, completion or extension of its plant or distributing system; within ten instead of five years prior to the filing of an application with the commission for the required authorization. This gives a steam company ten instead of five years after authorization to actually issue or complete an issue of stocks, bonds or notes.

Third, Governor Roosevelt signed the bill that provides for an extensive survey of the Public Service Commission. It carries an appropriation of $40,000 to cover the expenses of the investigating committee, and instructs that committee to study thoroughly the public service commission laws of New York and other states to see if the law of New York State accomplishes adequate regulation and to determine what revisions, if any, are needed.

All three laws became effective on the dates they were signed by the Governor.

Program of Oil Power Meeting Announced

The committee engaged in working up the program for the National Oil Power Conference, to be held at Pennsylvania State College, State College, Pa., June 24 to 27, announces that almost all of the papers have been obtained.

Among the subjects to be discussed will be "High-Speed-Engine Design," "Fuel Pumps," "Application of High-Speed Diesels," "Maintenance of Engines," "Diesel Education," and "Motorship Progress." In addition there will be committee reports on "Diesel Oil Specifications" and upon "standardization of engine ratings."

The meeting will cover four days and ample time will be had for various sports and recreations.

France Develops Power Resources

Surpassed only by the United States and Canada, France is the third nation in the world in the amount of average annual hydro-electric resources, it is stated by the Trade Commissioner at Paris, Thomas Butts, in a report reviewing French development, just made public by the Department of Commerce.

According to the report electrification proceeded rapidly in France during the War. The invasion of German armies cut off some of the most profitable coal mines, so development of hydro-electric power became essential, it was explained. In 1913 only 13 per cent of the French communes were furnished with power lines, while now the percentage is 53.

At the same time it is well recognized in France that the steam plant is a logical auxiliary to the hydro-electric plant because of the fluctuating quantity of water available in the various seasons and in times of excessive drought and also because of the need to meet peak loads. In spite of the great activity in water-power development, the production of steam power has also increased. In 1925 official estimates placed the steam power plant capacity at 3,228,848 kw. at a time when hydro-electric plants could produce but 1 813,000.

The recent expansion of the steam energy-producing industry has been characterized by two major developments: First, the increase in size of such plants, and secondly, the appearance of the coal-mining companies as competitors. Before the war energy-

producing companies were customers of the mining companies, the latter confining their activities solely to the production of coal as such. Now the mining companies can produce with their own plants 395,000 kw. of energy. Concurrent with the appearance of new competitors, the already established industry has increased its production from 116,500 kw. in 1913, to 315,000 kw. in 1925.

Today, through measures instituted by the government, France has complete co-ordination of development and interconnection of hydro-electric and steam plants, whether constructed, in process of construction or planned for the future.

Drexel Institute Opens New Laboratory

The Drexel Institute of Philadelphia will formally open Curtis Hall Engineering Laboratory on Thursday morning, May 2, 1929. Dean R. C. Disque is in charge of the exercises which start at 11:30 A.M.

The new laboratory is housed in a building donated by Cyrus H. K. Curtis at a cost of $600,000. It will be devoted primarily to engineering. Extensions to the electrical, civil, chemical and mechanical engineering laboratories are contained on the first floor which approximately double the present facilities devoted to these subjects.

Old Engine Purchased by Henry Ford

An old upright stationary steam engine which has been in almost constant operation for more than seventy years has been purchased by Henry Ford from the Georgian Foundry, of Meaford, Ontario. The life history of this engine in brief is as follows: It was built by Crombie & Company of Galt, Ontario, in 1858. It was operated in Ainsley's distillery, Leith, Ontario, from 1859 to 1867, and in the iron foundry at Meaford from 1867 to 1929.

Mr. Ford's representative first endeavored two years ago to purchase this engine, the mate of which he had bought at that time from the Goderich, Ontario, Tannery (the only difference being one foot in diameter of flywheel, the Goderich engine having a flywheel diameter of seven feet). These twin relics, it is understood, will be re-erected on a concrete pedestal at the Dearborn headquarters of Mr. Ford's plant.

Iowa Power Show

The Iowa Power and Industrial Exposition will be held at Marshalltown, on June 5-7 of this year. It is expected to be the largest industrial and power show in Iowa. Many exhibitors have signified their intentions of presenting displays and have already secured booths. All reservations for space should be sent to Mr. Eige, chairman of the Booth Committee.

Coming Conventions

American Boiler Manufacturers Association. Annual meeting, June 3-5, Sky Top Lodge, Cresco, Pa. A. C. Baker, secretary, 801 Rockefeller Blvd., Cleveland, O.

American Institute of Electrical Engineers, annual summer convention, Swampscott, Mass., June 24-28. Pacific Coast Regional Meeting, Santa Monica, Calif. Sept. 3-6. F. L. Hutchinson, secretary, 33 West 39th St., New York City. Regional Meeting, May 7-9, at Dallas, Texas. Secretary, A. E. Allen.

American Institute of Refrigeration, at Washington, May 2, 3, 1929. Louis Baron, secretary, 203 West 13th St., New York City.

American Society of Heating and Ventilating Engineers, annual summer meeting, Bigwin Inn, Lake of Bays, Ontario, Can., June 26-28. A. V. Hutchinson, secretary, 29 W. 39th St., New York City.

American Society of Mechanical Engineers, spring meeting, Salt Lake City, Utah, July 1-4, 1929. Rochester regional spring meeting, Rochester, N. Y., week of May 13. Calvin Rice, secretary, 29 West 39th St., New York City.

American Society for Testing Materials. Annual meeting, June 24-28, at Chalfonte-Haddon Hall, Atlantic City, N. J. Secretary, C. L. Warwick, 1315 Spruce St., Philadelphia, Pa.

American Welding Society, annual meeting to be held in New York City, April 24-26. Secretary M. M. Kelly, society headquarters, 33 West 39th St., New York City.

Association of Iron and Steel Electrical Engineers, 25th annual convention, Pittsburgh, Pa., June 17-22, 1929. A. A. Stewart, secretary, Pittsburgh Steel Co., Monnessen, Pa.

Canadian Electrical Association, annual convention, to be held June 19-21, at St. Andrews-by-the-Sea, N. B. H. M. Lyster, secretary, Power Building, Montreal, Que.

Master Boiler Makers Association, at Atlanta, Ga., May 21-24. H. D. Vought, secretary, 26 Cortlandt St., New York City.

National Association of Power Engineers, 47th annual convention, Chattanooga, Tenn., Sept. 9-13. Fred Raven, secretary, 417 South Dearborn St., Chicago, Ill. N. J. State Association annual meeting, June 1-2, at Eagles Hall, Elizabeth, N. J.

National Board of Boiler and Pressure Vessel Inspectors. Annual meeting, June 18-20, at Detroit, Mich. Secretary, C. O. Myers, 14 Commercial Nat'l Bank Bldg., Columbus, Ohio.

National Electric Light Association. Annual meeting at Atlantic City, N. J., June 3-7. A. J. Marshall, secretary, 420 Lexington Ave., New York City.

National Exposition of Power and Mechanical Engineering, Grand Central Palace, New York City, Dec. 2-7. Charles F. Roth, manager, Grand Central Palace, New York City.

National Oil and Gas Power Meeting. Under auspices of A.S.M.E. Oil and Gas Power Division and the Pennsylvania State College. June 24-27, State College, Pa. F. G. Hechler, chairman, State College, Pa.

Northwest Electric Light and Power Association. 22nd Annual Convention, June 26-29, 1929, at Seattle, Wash. Registration and information: J. J. Hayes, Westinghouse Electric & Manufacturing Company, Seattle, Wash.

World Engineering Conference, Tokyo, Japan, October, 1929. All correspondence should be addressed to the Secretary, World Engineering Conference, Nikon, Kogyo Club, Morunouchi, Tokyo.

Johns-Manville Expands Product Line

The Johns-Manville Corporation will enter the second quarter of 1929 actively merchandising the largest number of products in the company's history, according to a statement made by William R. Seigle, Chairman of the Board. Announcement was also made of the acquisition from Italy of the United States and Canadian rights for the manufacture and distribution of a new commodity, Transite seamless pipe, made of asbestos fiber and Portland cement, which the company will shortly place on a quantity production basis.

Specially designed machinery for the manufacture of this pipe is now being built in Italy, and two complete units which will be installed at the Waukegan, Ill., plant of the Johns-Manville Corporation, it is expected, will be producing to their full capacity early in the fall. These two units will produce 2,000,000 feet of pipe a year, and preparations have already been made for increasing the capacity as needed.

Governor Dern to Call Power Conference

Toward a subsidiary agreement allocating the 7,500,000 acre-feet of water provided by the Colorado River Compact, Governor George H. Dern of Utah has announced his intention of requesting a conference between the adjacent states in the near future.

Shortly after Utah's ratification of the compact, the State Legislature forwarded a resolution to the United States Department of Interior asking a survey and classification of the lands in Wyoming, Colorado, Utah and New Mexico which would be subject to reclamation or power development under the Colorado River Agreement. Governor Dern pointed out that most of the area involved is government land over which the states have no control. He stated the belief that "no satisfactory four-state agreement can be reached in advance of a careful study of the agricultural and power potentialties of the respective states." The pending conference, however, is expected to lead at least to a preliminary understanding.

Power Alcohol Produced in Australia

So-called power alcohol is now being produced in Australia from sugar-cane waste. When it is mixed with gasoline, a satisfactory "anti-knock" motor fuel is obtained. This is being marketed by the Shell Company under the name of "Shellkol."

The project was initiated as a result of experiments carried out by Distillers, Ltd., of Edinburgh. As yet production is very small, being confined to one distillery at Plane Creek, Queensland. Plans have been made, however, to add at least two other distilleries at Cairns and Townsville.

PERSONALS

FREDERICK WIERK of Johnson & Wierk, Incorporated, consulting engineers of New York, sails for Europe April 27th, to investigate high-pressure boilers and paper-mill power problems.

JAMES C. KENNEDY was elected president of the Central & South West Utilities Company at the meeting of the board of directors recently.

H. A. VAN NORMAN has been made chief engineer and general manager of the newly created Department of Water and Power of Los Angeles. By consolidating the water and power bureaus, control will be centralized, duplication eliminated and efficiency increased.

GEORGE SAWYER, formerly with the Pacific Power and Light Company, has resigned to accept a position with the Electric Bond and Share Company. He will assume charge of the Mexican properties of its subsidiary, the American & Foreign Power Company.

DR. C. E. SKINNER, assistant director of engineering, Westinghouse Electric & Manufacturing Company, and delegate from the United States to the World Engineering Congress in Tokyo, has been making a tour of the Pacific Coast cities.

JOHN C. PANGBORN, vice-president of the Pangborn Corporation, and his family sailed on the S.S. "Olympic" on April 5 for an extended tour of the Continent.

H. L. SCHRECK has accepted the position of research engineer with the Treadwell Engineering Company, of Easton, Pa.

BUSINESS NOTES

THE MICHIGAN VALVE & FOUNDRY COMPANY, of Detroit, has recently inaugurated a new service, in charge of Eldon S. Clark, whereby technical advice is made available to those in charge of projects involving water supply and distribution, drainage and sewage works, particularly where piping is an important factor.

THE CONSOLIDATION COAL COMPANY announces the appointment of J. C. Shaw as assistant manager of the Portsmouth, N. H., office.

THE ILLINOIS STOKER COMPANY is now represented in the Pittsburgh territory by Bradshaw & Company, 530 Fourth Avenue, Pittsburgh, Pa.

HARVEY HUBBELL, INCORPORATED, has moved to larger quarters in the Chanin Building, 122 East 42nd Street, New York City.

THE BAILEY METER COMPANY has moved its Cincinnati office to larger quarters at Room 412 Union Central Building.

With the Society Sections

A. S. M. E., Metropolitan Section. Meeting April 24, Oil and Gas Power Division, Subject: "Diesel Power Plants for Large Buildings," by Edgar J. Kates, Consulting Engineer. Meeting April 29, Power Division, Subject: "The Modern Marine Power Plant," by W. Flanders and P. Lamb.

A. S. M. E., Philadelphia Section. Meeting, April 23. Subjects: "Petroleum and Oil—The use of centrifugal pumps for hot and cold oil and other liquids at various pressure up to 1,400 lb. per sq.in.," by W. R. Layne, Chief Engineer, Byron-Jackson Pump Manufacturing Company, Dallas, Texas; "Diesel Engine," by Julius Kuttner, Editor, Oil Engine Power, New York, N. Y.

American Engineering Council. Meeting May 24-25, at Washington, D. C., of Administrative Board.

Boston Engineers' Club. Meeting May 15. Subject: "Pulverized Fuel Systems," by Henry Kreisinger, research engineer, Combustion Engineering Corporation.

The Newcomen Society. Fifth American meeting, April 24. Unveiling of tablet on grave of Josiah Hornblower, Belleville, N. J., at 4:30 p.m. Dinner and meeting, Engineers' Club, at 7:00 p.m. Subjects: "First Steam Engine in America," by L. F. Loree; "Evolution of the Typewriter," by John H. Barr.

TRADE CATALOGS

MAGNETIC SEPARATORS — The Magnetic Manufacturing Company, Milwaukee, Wis., announces the issuance of a new bulletin No. 80, devoted to magnetic separation equipment for the concentration of ores and minerals. The bulletin contains instructive theoretical and practical experience gained during thirty years of study in this field.

WATER SOFTENER—The Graver Corporation, East Chicago, Ill., has issued a new catalog of 12 pages, describing its hot-process water softener. It is illustrated and several tables are given showing the savings made by use of the softener. A feature is a flow sheet in colors.

PIPING—Bulletin No. 11, put out by the National Tube Company, Pittsburgh, Pa., is on the subject of copper-steel pipe. There are photographs of pieces of pipe showing the influences of different kinds of corrosion, which is eliminated by the use of the copper-bearing steel.

STOKERS—The improved Jones side-dump stoker is described and illustrated in a 24-page booklet published by the Riley Stoker Corporation, of Worcester, Mass. There are also line cuts of typical installations.

VULCABESTON PRODUCTS—The products of Colt's Patent Fire Arms Manufacturing Company, Hartford, Conn., known as Vulcabeston products, have been listed, with the addition of a few illustrations, in a 40-page pocket booklet.

DIESEL ENGINES — Chicago Pneumatic M.W.M. Benz Diesel Engines, Type RH 75, Bulletin 775, is the subject and number of the recent bulletin put out by the Chicago Pneumatic Tool Company, 6 East 44th St., New York City. It has 24 pages and is illustrated.

AERO UNIT SYSTEM—A 52-page catalog covering briefly the development and application of the aero unit system of pulverized fuel, is published by the Foster Wheeler Corporation, 165 Broadway, New York City. It is profusely illustrated both by photographs of installations and by corresponding line drawings giving sectional elevations.

DUST ELIMINATION—A highly technical discussion of the research done and of some of the applications made in the history of air filters, is the material in a 24-page booklet published by the Midwest Air Filters, Incorporated, Bradford, Pa. It contains explanatory diagrammatic sketches.

FUEL PRICES

COAL

The following table shows the trend of the spot steam market in various coals, f.o.b. mines; mine run, except Pittsburgh gas slack:

Bituminous (Net Tons)	Market Quoting	Price per Ton
Navy Standard	New York	$2.20@$2.55
Kanawha	Columbus	1.25@ 1.50
Smokeless	Cincinnati	1.85@ 2.00
Smokeless	Chicago	1.65@ 2.25
S. E. Kentucky	Chicago	1.35@ 1.65
Steam	Pittsburgh	1.40@ 1.75
Gas Slack	Pittsburgh	1.00@ 1.20
Big Seam	Birmingham	1.25@ 1.50
Anthracite (Gross Tons)		
Buckwheat	New York	$2.50@$3.25
Barley	New York	1.40@ 1.75

FUEL OIL

New York—Apr. 18, f.o.b. Bayonne, N. J., 28@34 deg., Baumé, industrial use, tank-car lots, 5c. per gal.; 36@40 deg., furnace, tank-car lots, 6.25c. per gal.

St. Louis—Apr. 10, tank-car lots, f.o.b. St. Louis, 24@26 deg., $1.3959 per bbl. or 42 gal.; 26@28 deg., $1.4459 per bbl.; 28@30 deg., $1.4459 per bbl.; 30@32 deg., $1.5459 per bbl.; 32@36 deg., gas oil, 4.526c. per gal.; 38@40 deg., distillate, 5.48c.

Pittsburgh—Apr. 3, f.o.b. local refinery, 30@34 deg., fuel oil, 5c. per gal.; 36@40 deg., 5.5c. per gal.

Philadelphia—Apr. 11, 13@19 deg., $1.05@$1.10 per bbl. or 42 gal.; 22 deg. plus, $1.66@$1.71 per bbl.; 23@27 deg., $2.10@$2.15 per bbl.

Cincinnati—Apr. 8, tank-car lots, f.o.b. local refinery, 24@26 deg. Baumé, 5c. per gal.; 26@30 deg., 5.5c. per gal.; 30@32 deg., 5.95c. per gal.

Chicago—Apr. 8, tank-car lots, f.o.b. Oklahoma, freight to Chicago, 90c. per bbl. or 42 gal.; 22@26 deg., 65c. per bbl.; 26@30 deg., 75c. per bbl.; 30@32 deg., $1.20 per bbl.

Boston—Apr. 15, tank-car lots, f.o.b. 12@14 deg. Baumé, 4.45c. per gal.; 28@32 deg., 5.65c. per gal.

Dallas—Apr. 8, f.o.b. local refinery, 26@30 deg., $1.25 per bbl. or 42 gallons.

New Plant Construction

COMPILED BY THE MCGRAW-HILL BUSINESS NEWS DEPARTMENT, WHICH IS PREPARED TO FURNISH A MORE COMPLETE DAILY SERVICE TO THOSE WHO WISH IT

Calif., Los Angeles—Los Angeles Gas & Electric Co., 810 South Flower St., is having plans prepared for the construction of a sub-station at 10th and Hobart Sts. Estimated cost $15,000. Private plans.

Calif., Riverside — Southern Sierras Power Co. awarded contract for the construction of a power plant, transformer room, etc. on North Main St. to W. J. Nethery & Son. Estimated cost $175,000.

Calif., Santa Cruz—City plans to vote on question whether city shall accept or reject offer of Peoples Construction Co., San Francisco, to construct a hydro-electric plant and dam on San Lorenzo River, also transmission line and system for distribution of electric energy, to lease same to city for 40 year term at annual rental. R. Fowler, is city engineer.

Calif., Stockton—California Water Service Co. will receive bids about May 1 for the construction of a new pumping plant, mains, etc., in connection with waterworks. Estimated cost $100,000.

Idaho, Sandpoint — City voted $300,000 bonds for the construction of a municipal power plant on Priest River.

Ill., East St. Louis—Mobile & Ohio R.R., Fullerton Bldg., St. Louis, awarded contract for the construction of a round house, boiler and power house, etc., to Ellington-Miller Co., 417 South Dearborn St., Chicago. Estimated cost to exceed $400,000.

Ill., Springfield—City plans waterworks improvements including wells, purification plant, boiler equipment, etc. Estimated cost $41,000. J. E. Smith, Mayor.

Ia., Irwin—City plans an election June 7 to vote $17,000 bonds for the construction of a waterworks system to include deep well, pump house, pumps, tank on tower, etc. Henningson Engineering Co., 326 Union State Bank Bldg., Omaha, is engineer.

Ia., Muscatine—Muscatine-Louisa Counties Drainage Dist. 13, C. H. Pitchforth, Auditor, will readvertise for bids for electrification of pumps 1 and 3 at Port Louise Station. Central State Engineering Co., Muscatine, is engineer. Former bids rejected.

Ia., Sioux City — Sisters of St. Francis, Dubuque, plan the construction of a group of college buildings including power plant, etc. on Briarcliffe St. Estimated cost $200,000. Steele & Hilgers, Sioux City, are architects.

Ia., Vinton —City, A. H. Houlihan, Councilman, plans to revamp and improve municipal light and power plant to include new turbines, etc. Estimated cost $50,000.

Mass., Fall River — City, J. A. Burke, plans the construction of a dam to include pumping equipment at Watuppa reservoir. Estimated cost $250,000.

Mass., Somerville (Boston P. O.)—Monks & Johnson, 99 Chauncy Ave., Boston, Engrs., will receive bids until Apr. 30, for the construction of a meat storehouse to include refrigeration plant on Mystic Ave. here for First National Stores, 5 Middlesex Ave., Somerville. Estimated cost $1,500,000.

Mo., Salem—City voted $25,000 bonds for the construction of an electric light plant, also distribution lines.

N. J., Williamstown—Atlantic City Electric Co., E. A. Lewis, Pacific and Kentucky Aves., Atlantic City, is receiving bids for the construction of an electric sub-station here. Estimated cost $40,000. C. H. Higgins, 101 Park Ave., New York, is architect.

N. Y., New York—New York Edison Co., M. Sloan, Pres., 30 East 15th St., plans the construction of a 206 x 355 ft. power plant at 701 East 14th St. Estimated cost $965,000.

O., Apple Creek — Ohio Legislature, Columbus, appropriated $774,000 for the construction of a group of buildings including power house, etc. for Institution of Feeble Minded here.

O., Cleveland—Shaker Co., c/o Van Sweringen Co., Terminal Tower, is having plans prepared for the construction of a central heating plant at East 132nd St. and Shaker Blvd. Estimated cost $200,000. P. L. Small, 1836 Euclid Ave., is architect and engineer.

Pa., Philadelphia — Childrens' Hospital, 18th and Bainbridge Sts., plans the construction of a group of hospital buildings including power house, etc. Estimated cost $1,500,000. Stewardson & Page, 315 South 15th St., are architects.

Pa., Philadelphia — Philadelphia Gas Works, 1401 Arch St., awarded contract for the construction of a power plant at 56th and Lindberg Sts. to Haverstick & Borth wick, Schaff Bldg.

Pa., Pittsburgh—Duquesne Light Co., 435 6th Ave., will build a power plant to include coal handling equipment at Brunots Island. Estimated cost $9,000,000. Byllesby Engineering & Management Corp., 105 West Adams St., Chicago, Ill., is engineer.

Texas—Cameron County Water Improvement Dist. 8, C. P. Barreda, Brownsville, voted $1,000,000 bonds for the construction of an irrigation project to include pumping plant, etc. Private plans.

Tex., Austin—City, A. R. Johnson, Mgr., is having plans prepared for extensions and improvements to electrical distribution system to include two sub-stations, one near city power plant and one in Hyde park. Estimated cost $200,000. W. E. Seaholm is engineer.

Tex., El Paso—El Paso Electric Co., C. F. W. Wetterer, Pres., subsidiary of Engineers Public Service Co., Inc., 120 Broadway, New York, N. Y., awarded contract for the design and construction of a 40,000 kw. power station on Rio Grande River near here.

Ont., Amherstburg—Pioneer Distillers, is having plans prepared for the construction of intake crib and electrically operated pumping station. Estimated cost $50,000.

Ont., Niagara Falls—American Cyanamid Co., 535 5th Ave., New York, N. Y., is having plans prepared for the construction of a hydro-electric plant here as part of $9,000,000 construction program.

Equipment Wanted

Boiler, Combustion Equipment, etc. — Spencer Kellogg & Sons Inc., 2200 Lumber St., Chicago, Ill., E. Agster, Supt., catalogs on boilers, combustion equipment and other auxiliary equipment for proposed boiler plant.

Generator, etc.—Treasury Dept., Office of Supervising Architect, Washington, D. C., will receive bids until Apr. 29 for furnishing and installing motor generator, etc., at U. S. Mint, Philadelphia, Pa.

Motor—City of Normal, Ill., plans to purchase a new motor for waterworks.

Pump and Motor—City of Norton, Kan., will soon receive bids for one 500 g.p.m. centrifugal pump and motor for proposed waterworks.

Pumping Unit—City of El Paso, Tex., pumping unit, etc., for proposed waterworks improvements. Estimated cost $700,000.

Pumping Units—Bd. of Water Commissioners, W. T. Skrzycki, Pres., Detroit, Mich., will receive bids until May 15, for motor-driven centrifugal pumping units for high lift plant, Springwells station.

Pumps, etc.—City of Merriam, Neb., pumps, etc., for proposed waterworks improvements. Estimated cost $15,000.

Pumps, etc.—City of Wewoka, Okla., plans to purchase two 500 g.p.m. pumps for proposed booster station at Wewoka. Estimated cost $16,000.

Regulators—Bd. of Purchases, H. C. Cain, Secy., City Hall, Columbus, O., is in the market for four 40 kva. complete current regulators, also forced draft feed type mechanical stoker for municipal light plant.

Turbine—City of Moorhead, Minn., plans furnishing and installing 1,500 kw. turbine for electric light and power plant. Estimated cost $50,000.

Industrial Projects

Conn., Bridgeport — TUBE MILL AND STORAGE BUILDING—Bridgeport Brass Co., R. E. Day, Gen. Mgr., East Main St., awarded contract for the construction of a 1 story, 40 x 120 ft. tube mill and storage building to Hewlett Co., 884 Main St. Estimated cost $100,000.

Md., Baltimore — AIRPLANE — FACTORY — E. Katzinger Co., 1949 North Cicero Ave., Chicago, Ill., awarded contract for a 2 story, 143 x 180 ft. factory at Fleet and Haven Sts. to M. A. Long Co., 10 West Chase St., Baltimore. Estimated cost $150,000.

Mich., Monroe—STEEL MILL—Newton Steel Co., First National Bank Bldg., Youngstown, O., awarded contract for substructure of a 1 story, 300 x 1,500 steel mill here to Walbridge Aldinger Co., Penobscot Bldg., Detroit. Separate power plant. Electric motors, etc. will be installed.

N. H., Laconia—FACTORY and BOILER HOUSE—Scott & Williams Inc., 299 Union Ave., awarded contract of a 4 story, 60 x 180 ft. factory and boiler plant, to Temple & Crane Inc., 99 Chauncy St., Boston. Estimated cost $150,000.

N. J., Jersey City — IRON CEMENT PLANT — Smooth-On Mfg. Co., 572 Communipaw Ave., awarded contract for a 3 story, 25 x 60 ft. addition to iron cement plant at Communipaw and Harrison Aves. to P. F. Redfern, 569 Jackson Ave. Estimated cost $40,000.

O., Cincinnati — RADIO FACTORY — Crosley Radio Co., Colerain Ave., will soon award contract for an 8 story factory. Estimated cost $500,000. S. Hannaford & Sons, Dixie Terminal, are architects.

O., Cleveland—CONTROLLER FACTORY —Clark Controller Co., P. C. Clark, Pres., 1146 East 152nd St., awarded contract for a 1 story, 40 x 120 ft. addition to factory to J. L. Hunting Co., Guarantee Title Bldg. Estimated cost $40,000.

O., Massillon—RIVET FACTORY—Massillon Rivet & Mfg. Co., plans the construction of a 1 story, 38 x 100 ft. factory on Erie St. S. Estimated cost $40,000. Private plans.

Pa., Bedford—INSULATOR FACTORY—May & Bigley, Altoona, will build a 2 story, 54 x 100 ft. factory here. Estimated cost $50,000. D. G. Ruderbaugh, Altoona, is architect. Work will be done by separate contracts.

Pa., Emporium—RADIO TUBE PLANT ADDITION — Sylvania Products Co. awarded contract for a 2 story, 80 x 240 ft. addition to radio tube plant to Rust Engineering Co., American State Bank, Pittsburgh. Estimated cost $150,000. E. White, c/o owner, is engineer.

Pa., Irvineton (mail Irvine)—STEEL PLANT ADDITION—National Forge & Ordnance Co., plans a 1 story, 160 x 300 ft. addition to steel plant. Estimated cost $100,000. Work will be done by separate contracts under the supervision of B. R. Shaver, Oliver Bldg., Pittsburgh, Engr.

Pa., Pittsburgh—SAW TRIMMER FACTORY—Miller Saw Trimmer Co., Point Bldg., will receive bids until Apr. 18 for a 1 and 2 story, 84 x 157 ft. addition to factory at Sproat Way. Estimated cost $150,000. Hunting Davis & Dumulls, Century Bldg., are architects.

Tenn., Alcoa—BRONZE POWDER MILL —Aluminum Co. of America, Oliver Bldg., Pittsburgh, Pa., will build a 1 story bronze powder mill here. Estimated cost $1,000,000. Private plans. Work will be done by separate contracts.

Que., Lasalle — YEAST PLANT and POWER HOUSE—Fleischmann Yeast Co. of Canada, St. Urbain St., Montreal, plans the construction of a 1 story, 80 x 80 ft. plant to include engine room, power house and pumping station, cutting and wrapping building, etc. Estimated cost $500,000. Laurentide Construction Co. Ltd., Canada Cement Bldg., Montreal, is engineer.